GROUNDWATER EXTRACTION AND MONITORING SYSTEM

REMEDIAL DESIGN REPORT

Simplot Operable Unit

Eastern Michaud Flats Superfund Site

Pocatello, Idaho

June 2010

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Acronyms and Abbreviations

AFLB	American Falls Lake Bed
ANP	Acid Neutralization Potential
AOC	Administrative Order on Consent
ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CMP/CQAP	Construction Management Plan and Construction Quality Assurance Plan
COC	Contaminants of Concern
CSM	Conceptual Site Model for groundwater
DAF	Dilution and Attenuation
EMF Site	Eastern Michaud Flats Superfund Site
ENU	Elementary Neutralization Unit
EPA	Environmental Protection Agency
FS	Feasibility Study
ft	feet
gpm	gallons per minute
HDPE	high density polyethylene
IDEQ	Idaho Department of Environmental Quality
in	inches
IRODA	Interim Amendment to the Record of Decision
kg/day	kilograms per day
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
O&M	Operations and Maintenance
OU	Operable Unit
PAP	Phosphoric Acid Plant
POC	Point of Compliance
POTW	Pocatello Waste Water Treatment Plant
QA	Quality Assurance
RAC	Remedial Action Coordinator

Acronyms and Abbreviations (cont.)

RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RDR	Remedial Design Report
RI	Remedial Investigation
RAO	Remedial Action Objectives
ROD	Record of Decision
RPM	Remedial Project Manager
sf	square feet
SM	Site Manager
SOW	Remedial Design/Remedial Action Consent Decree Statement of Work
TDS	total dissolved solids
t/kt	tonne per kilotonne
TMDL	Total Maximum Daily Load
VCO/CA	Voluntary Consent Order/Compliance Agreement
VFD	Variable Frequency Drive
XRD	X-Ray Diffraction

1.0 INTRODUCTION

This document provides the final design of the groundwater extraction and monitoring systems for the Simplot Operable Unit (OU) of the Eastern Michaud Flats Superfund Site (the “EMF Site”) located near Pocatello, Idaho (Figure 1-1). The groundwater extraction and monitoring systems are being implemented as part of the comprehensive remedy for the Simplot OU as described in the Environmental Protection Agency (EPA) Record of Decision (ROD; EPA, 1998) and Interim Amendment to the Record of Decision (IRODA; EPA 2010). This document complies with the Remedial Design/Remedial Action Consent Decree (CD; EPA, 2002), as amended in 2010 (hereafter “Consent Decree”).

Extraction of groundwater will be performed in conjunction with source control actions. Groundwater extraction will reduce the concentration of Contaminants of Concern (COCs) in groundwater discharging to the Portneuf River.

The groundwater extraction system is being installed in a “phased and integrated approach” (EPA 1997). In this approach, test extraction wells have been installed and tested to provide location-specific performance data. The extraction system will consist of the existing test extraction system that has been installed in previous investigation phases, along with additional proposed extraction wells that meet Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and VCO/CA objectives. Monitoring wells and exploratory borings have also been installed in phases to address specific data gaps in the site conceptual model for groundwater. Uncertainties in the Conceptual Site Model (CSM) for groundwater have been greatly reduced with the completion of each phase of the extraction system and sufficient information is now available to design the remaining elements of the system, demonstrate that the complete system will meet remedy objectives, and plan the steps necessary to implement the design.

This document is organized as follows:

- **Design Criteria** – The groundwater remedy, remedy objectives, and performance standards are detailed in the Consent Decree These standards and other design criteria are also included in Section 2.

- **Background** – Pertinent background information including a summary of previous investigations, a description of facility operations, and a detailed description of the CSM for groundwater flow and constituent transport are included in Section 3.

- **Design of Extraction and Monitoring Systems** – The remedial design methodology, calculations that support the design of the groundwater extraction and monitoring systems and the resulting design of the systems are described in Section 4.

- **The Construction Management Plan and Construction Quality Assurance Plan (CMP/CQAP)** – The CMP/CQAP is included in Section 5.

- **Operation and Maintenance** – Operation and maintenance issues are discussed in Section 6.

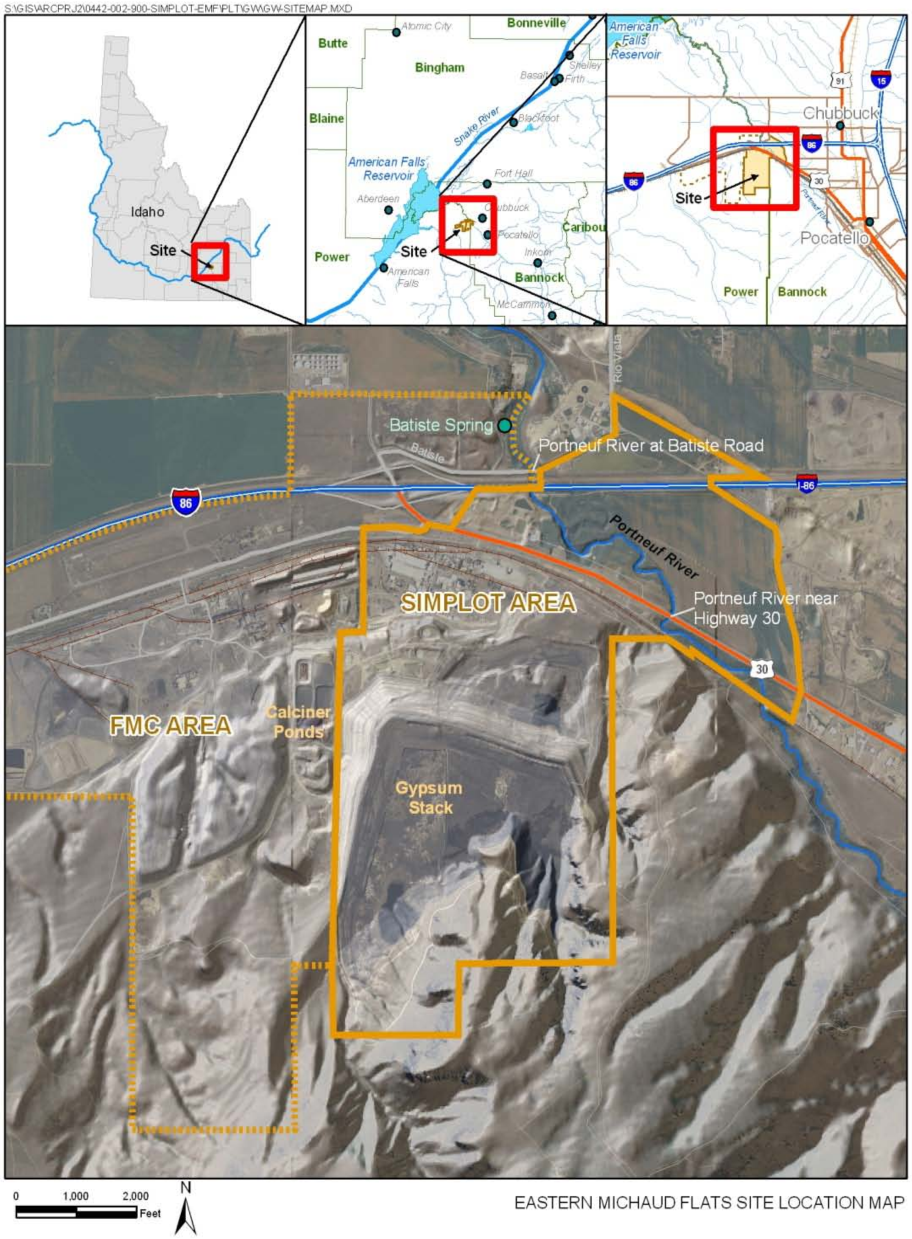

Figure 1-1: Site Location Map

1.1 Site Description

The EMF Site is located near the City of Pocatello, Idaho and includes two industrial facilities (Figure 1-1): the FMC Elemental Phosphorus Facility (which ceased operations in December 2001) and the J.R. Simplot Don Plant. The Don Plant produces phosphoric acid and a variety of liquid and solid fertilizers. The U.S. Environmental Protection Agency (EPA) has divided the Site into three OUs (Figure 1-2): the FMC OU includes the FMC facility and adjacent land owned by FMC; the Simplot OU includes the Don Plant and adjacent land owned by Simplot; and the Off-Plant OU which is the remainder of the Site.

The Simplot Don Plant covers approximately 745 acres and adjoins the eastern property boundary of the FMC facility. The main portion of the plant lies approximately 500 feet southwest of the Portneuf River. Of the 745 acres, approximately 400 acres are committed to the gypsum stack. Another 185 acres are occupied by the plant and its infrastructure. A significant portion of the remaining acreage to the south and southeast of the plant consists of cliffs and rugged steep terrain. A Union Pacific Railroad right-of-way is adjacent to the northern fence line of the Don Plant and passes through the northern portion of the Simplot Plant Area, paralleling U.S. Highway 30. Access to the Don Plant is provided by Interstate 86 and U.S. Highway 30.

The Don Plant began production of a single superphosphate fertilizer in 1944. Phosphoric acid production began in 1954. The plant currently produces a variety of solid and liquid phosphorus- and nitrogen-based fertilizers. The principal raw material for the process is phosphate ore, which is transported to the facility via a slurry pipeline from the Smoky Canyon mine. The primary byproduct from the Don Plant process is gypsum (calcium sulfate) which is stacked on-site.

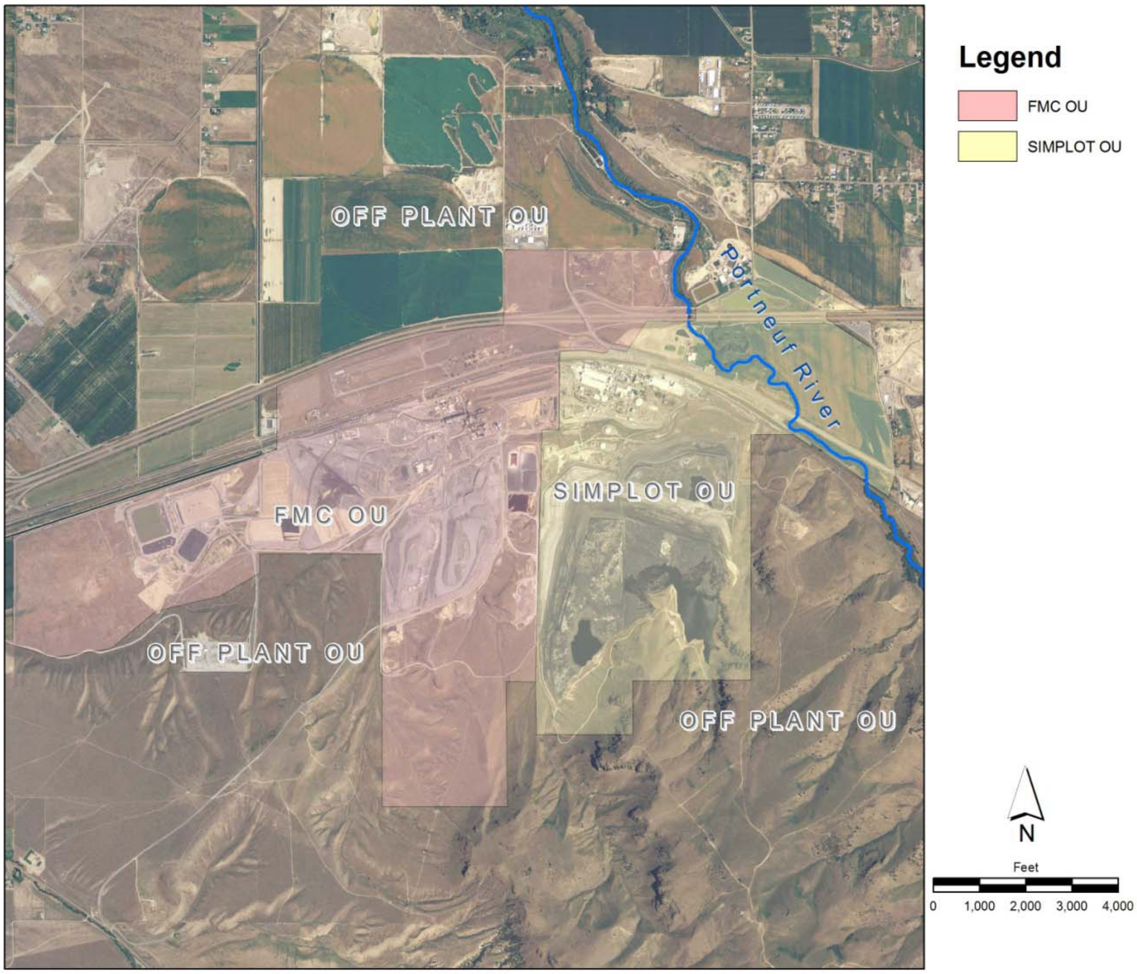

Figure 1-2: Boundaries of Simplot and FMC Areas

1.2 Project History

An Administrative Order on Consent (AOC) was issued by the EPA on May 30, 1991 and entered into voluntarily by FMC and Simplot. The AOC specified requirements for implementation of a Remedial Investigation (RI) and Feasibility Study (FS) to evaluate EMF Site conditions and remedial alternatives to address potential threats to human health and the environment. Based on the findings of these studies, EPA issued a ROD (EPA, 1998), specifying the selected remedial actions for the Site on June 8, 1998. A Remedial Design/Remedial Action Consent Decree (EPA, 2002) between EPA and Simplot, which specified the conditions for implementing the selected remedial actions in the Simplot Plant Area, was entered on May 9, 2002.

Consistent with the requirements of the Decree, Simplot submitted a Draft Groundwater Extraction Remedial Design Report (RDR) and Prefinal Groundwater Monitoring RDR in August 2002 (MFG 2002a and 2002b, respectively). Subsequent discussions between Simplot and the regulatory agencies in 2003 resulted in a phased path forward for the design and implementation of the groundwater extraction system. The underlying basis for this approach was to design and implement the extraction system in an incremental manner based on the results of actual performance data, rather than spending further effort attempting to better predict its effectiveness through additional modeling. This type of approach is consistent with the "phased and integrated approach" recommended by the RCRA/Superfund Groundwater Forum (EPA 1997). The approach was documented in a letter from Alan Prouty, Simplot, to Linda Meyer, EPA, dated May 23, 2003 ("Path Forward Letter", Simplot 2003).

Simplot completed the installation and testing of an initial test extraction system from 2003 to 2004 and began operation of ten test extraction wells in June 2004. Simplot submitted the Prefinal Groundwater Extraction RDR in November 2004. EPA, Simplot, and their representatives met to discuss the design report in December 2004 and EPA provided comments on the design in April 2005. In May 2005 Simplot and the agencies began an interactive process of revising the design of the groundwater extraction system. This process involved integrating more recent EPA guidance such as *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (in draft during the process and published in January 2008; EPA 2008). The process involved a number of meetings to transfer information with the goal of reaching consensus on design issues regarding the conceptual site model, identification of data gaps, design objectives, and required analyses. Simplot started a project website (NewFields 2005) at this time to document communications, field activities, and data analyses.

This interactive process resulted in five additional site investigations that were performed to fill data gaps in the groundwater CSM:

- The Phase 1 Data Gap Investigation (NewFields 2006a) was completed in late 2005 and early 2006 to investigate and evaluate the performance of the Upper Zone test extraction wells.

- Phase 2 Data Gap Investigation (NewFields 2008a) was completed over the period from 2006 to 2008 to further investigate and evaluate hydraulic properties and groundwater quality (NewFields 2008).

- A groundwater geophysical investigation (NewFields 2008c) was completed in the summer of 2008 to aid in the lateral and vertical delineation of contaminated groundwater in the Simplot OU between State Highway 30 and the Portneuf River.

- A special sampling event was completed in the spring of 2008 (NewFields 2008b). This sampling event incorporated an expanded list of analytes and sampling locations to the routine 2nd quarter 2008 quarterly monitoring scope.

- A subsurface investigation was completed in the Phosphoric Acid Plant (PAP) Area in the winter of 2008-2009 (Simplot 2009).

Work plans for each of these investigations were prepared by Simplot and approved by EPA and IDEQ. After field investigations, draft reports were prepared by Simplot and comments on the reports were prepared by the agencies. In addition, as part of the interactive process, Simplot prepared draft technical memoranda on design issues and agencies prepared comments on these memoranda. All documents have been placed on the project website and are available to all project team members. Collectively, this body of work provides the technical basis for the designs presented in this document.

Idaho Code § 39-3609 requires IDEQ to prepare a list of Idaho waters not meeting State Water Quality Standards. The Portneuf River was included on the list in 1994. In April 1999, IDEQ submitted to the EPA a Total Maximum Daily Load (TMDL) for the Portneuf River. The TMDL is in accordance with the State of Idaho Guidance for Development of Total Maximum Daily Loads (June 1999). The TMDL lists nutrients among pollutants that need to be addressed in the Lower Portneuf River. Based upon the narrative water quality criteria for nutrients, IDEQ has established a water quality target for total phosphorus for this segment of river as set forth in the approved TMDL. The target for total phosphorus in the Lower Portneuf River is 75 micrograms per liter at Siphon Road. Also in 2003, the Portneuf River TMDL Implementation Plan (IDEQ, 2003) identified mass reduction goals for known contributing sources, including approximately 95% reduction for EMF Site groundwater discharge. In the Plan, including written contributions from identified stakeholders, Simplot was required to meet the initial goals of the first phase of the TMDL, which was addressed by implementing the CERCLA groundwater extraction remedy that was selected in the ROD. Although the CERCLA remedy was selected to address arsenic, co-located phosphorus in groundwater will also be captured. The Portneuf River TMDL was developed in order to comply with Section 303 of the federal Clean Water Act, which requires IDEQ to adopt water quality standards that will restore the designated use of water bodies (IDEQ, 2003).

On April 11, 2008 Simplot signed the VCO/CA with IDEQ. The VCO/CA is intended to implement Simplot’s responsibilities at the Don Plant fertilizer manufacturing facility located near Pocatello Idaho under the approved TMDL for nutrients for the Lower Portneuf River. Under the VCO/CA Simplot is required to install a liner on the operating gypsum stack and continue to operate the CERCLA groundwater extraction system. The monitoring outlined in this plan will be used to assess the effectiveness of remedial actions in achieving the VCO/CA cleanup requirements in the Portneuf River. The monitoring requirements and objectives are described in Sections 2.2, 2.4.1 and 2.4.2.

In January 2010 EPA issued an Interim ROD Amendment (IRODA) for the Simplot Operable Unit (EPA 2010a). The IRODA adds the hazardous substance phosphoric acid (measured as total phosphorus or dissolved orthophosphate) as Contaminant of Concern (COC). It also provides for source control of COCs from the Simplot OU to the extent practicable, including the installation of a liner on the gypsum stack to stop infiltration to groundwater.

FMC is currently implementing a supplemental RI/FS to address issues associated with closure of the FMC plant. It will prepare a focused Feasibility Study Report and EPA will subsequently issue a ROD amendment for the FMC OU. Additional data are being generated in the Off-Plant OU. Depending on the findings, EPA may issue a ROD Amendment for that OU.

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2.0 REMEDIAL DESIGN CRITERIA

The groundwater extraction and monitoring system elements of the groundwater remedy are described in the CD SOW (EPA 2002) and the IRODA (EPA 2010). In addition, groundwater remedial actions and requirements for groundwater and surface water monitoring are specified in the VCO/CA. As set forth in the IRODA the remedial action for the Simplot OU includes phosphorus as a COC and provides appropriate modifications to the overall remedy. The VCO/CA provides target phosphorus concentrations for the Portneuf River based on the TMDL process. The following sections summarize remedial design criteria pertinent to the groundwater extraction and groundwater monitoring systems.

2.1 Description of Remedy

The major components of the Simplot OU groundwater extraction and monitoring systems are:

- The groundwater extraction system will consist of installation of a network of shallow and deep groundwater wells on the northern edge of the gypsum stack and/or the Phosphoric Acid Plant. It also includes any engineering controls to reduce the volume of water on the surface of the gypsum stack.

- The extracted groundwater will be conveyed to the Don Plant and recycled into the Don Plant process water system.

- Development and implementation of a verifiable plan to control primary and secondary sources of COCs within the Simplot OU in order to meet Maximum Contaminant Levels (MCLs) or risk-based concentrations (RBCs):

- Installation of a synthetic liner on the receiving surface of the gypsum stack to reduce water from infiltrating through the stack into groundwater;

- The groundwater extraction system will continue to be developed, operated, maintained and augmented to the extent necessary, if any, to keep arsenic and phosphorus levels at or below MCLs or RBCs shown in Table 2-1.

- Groundwater monitoring and evaluation shall be conducted as part of the cleanup remedy to determine the effectiveness of the extraction system and other source control measures in reducing the COCs within the Simplot OU to levels that achieve MCLs and RBCs.

- Development of a protective numerical cleanup level for phosphorus in groundwater consistent with achieving the TMDL for surface water in the Portneuf River (currently 0.075 mg/L).

- Identification of monitoring points in, and in the vicinity of, the Portneuf River.

- Simplot shall implement legally enforceable land use controls that will run with the land (e.g., deed restrictions, limited access, well restrictions and/or well head protection) to prevent ingestion of groundwater with COCs above MCLs or RBCs.

2.1.1 Groundwater Extraction

The groundwater extraction system will consist of installation of a network of shallow and deep groundwater wells on the northern edge of the gypsum stack and/or the Phosphoric Acid Plant and also includes any engineering controls to reduce the volume of water on the surface of the gypsum stack. The extracted groundwater will be conveyed to the Don Plant and recycled into the Don Plant process water system.

EPA recognizes that operation of the extraction system may not necessarily result in achievement of the MCLs or RBCs throughout the plant area and has not identified this as a performance criterion until closure of the gypsum stack. After closure of the gypsum stack, operation and maintenance of this system will continue until COCs in groundwater throughout the Simplot Plant Area are reduced to below MCLs or RBCs, or until EPA determines that continued groundwater extraction would not be expected to result in additional cost-effective reduction in COC concentrations within the Simplot OU. Institutional controls will remain in place to control groundwater use until MCLs or RBCs are achieved in the Simplot OU.

2.1.2 Groundwater and Surface Water Monitoring

Groundwater and surface water monitoring includes sampling and analysis of groundwater from selected wells, surface water from springs and the Portneuf River and the evaluation and reporting of the monitoring data.

2.2 Remedial Action Objectives and Performance Standards

The overall objective of the groundwater remedial actions for the Simplot OU is to provide an effective mechanism for protecting human health and the environment. To address the potential risks, the following groundwater cleanup objectives were developed and presented in the ROD and IRODA:

- Reduce the release and migration of COCs to groundwater from facility sources that may result in concentrations in groundwater exceeding RBCs or chemical specific Applicable or Relevant and Appropriate Requirements (ARARs), specifically MCLs.

- Reduce the release and migration of COCs to surface water from facility sources that result in concentrations in groundwater exceeding RBCs or chemical specific ARARs, including ambient water quality criteria (AWQC) pursuant to the Clean Water Act.

- Achieve source control for the existing gypsum stack and phosphoric acid plant area within the shortest practicable timeframe.

- Prevent potential ingestion of groundwater containing COCs having concentrations exceeding RBCs or MCLs (chemical specific ARARs) (see Table 36 of the ROD). The RBCs shown in the ROD, Table 36, correspond to a cancer risk of 10^{-6} or a Hazard Index of 1.0.

- Restore groundwater that has been impacted by EMF Site sources to meet all RBCs or MCLs for the COCs

Define groundwater and surface water human health and ecological RBC targets for phosphorus consistent with the TMDL for surface water in the Portneuf River.

The applicable MCLs and RBCs are included in Table 2-1.

The VCO/CA specifies the remedy goal of meeting the following concentration-based requirements in the Portneuf River as measured at Siphon Road:

- Achieve a 50 percent reduction (0.625 mg/L) in the concentration of total phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2013.

- Achieve a 75 percent reduction (0.938 mg/L) in the concentration of total phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2015.

- Achieve a 94 percent reduction (1.175 mg/L) in the concentration of total phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2021. This level equates to the water quality target of 0.075 mg/L established for total phosphorus for this segment of river as set forth in the approved TMDL.

The baseline condition determined by IDEQ is 1.250 mg/L as the annual median of monthly samples, based on data collected from 2004 to 2007.

Table 2-1: Risk-based and Maximum Contaminant Level for Groundwater COCs

Contaminant of Concern [1]	Units	Maximum Contaminant Level (MCL)	Risk-Based Concentration (RBC) [1]
Antimony	mg/L	0.006	0.006
Arsenic [2]	mg/L	0.010	0.000048
Beryllium	mg/L	0.004	0.000019
Boron	mg/L	NA	1.36
Cadmium	mg/L	0.005	0.008
Chromium	mg/L	0.1	0.077
Fluoride	mg/L	4.0	0.93
Manganese	mg/L	NA	0.077
Mercury	mg/L	0.002	0.0046
Nickel	mg/L	NA [3]	0.299
Nitrate	mg/L	10	25.03
Phosphorus	mg/L	NA	NA [4]
Selenium	mg/L	0.05	0.39
Thallium	mg/L	0.002	0.07
Vanadium	mg/L	NA	0.001
Zinc	mg/L	NA	0.108
Tetrachloroethene	mg/L	0.005	3.92
Trichloroethene	mg/L	0.005	0.001
Radium 226 [5]	pCi/L	5	0.002
Gross Alpha	pCi/L	15	NA
Gross Beta	millirems/yr	4	NA

[1] From ROD Table 36
[2] The MCL for Arsenic was revised to be 0.010 mg/L in 2006.[3] The MCL and MCLG for nickel were remanded on February 9, 1995
[4] The RBC for phosphorus will be determined as described in Section III.7.d of the SOW.
[5] Combined for Radium 226 and Radium 228

2.2.1 Objective of Groundwater Remedy

The objective of the groundwater remedy is to prevent the migration of arsenic, phosphorus, and other COCs at concentrations above MCLs or groundwater RBCs into the Off-Plant OU, and to achieve source control for the existing gypsum stack and PAP Area. Where there is an MCL, the MCL shall control. The extraction system, in combination with the institutional controls program, phosphorus source controls and the groundwater and surface water monitoring program, will address this remedial action objective and the overarching objective of protecting human health and the environment. The extraction system shall operate at least as long as the gypsum stack is receiving gypsum or liquids.

Performance standards for the groundwater extraction system are as follows:

- Demonstrate hydraulic control for groundwater influenced by gypsum stack seepage. Preliminary work indicates the cumulative annual average pumping rate necessary to achieve hydraulic control during operation of the gypsum stack is 750 gpm. The annual average pumping rate will be established through system design, including the schedule for implementation and achievement of the required pumping rate. At a minimum, the implementation schedule will allow for a system startup period of one year.

- Once the annual average pumping rate has been achieved, the performance standard will be the MCLs or groundwater RBCs for arsenic, phosphorus and other COCs, as measured at appropriate Off-Plant Area locations as determined by EPA. Where there is an MCL, the MCL shall control.

While not specifically stated in the IRODA or Consent Decree, the performance of the groundwater extraction system in the PAP Area is implied in these documents. These performance standards for the groundwater extraction system down gradient of the PAP Area are as follows:

- Demonstrate hydraulic control for groundwater influenced by seepage of impacted groundwater from the PAP Area.

- Demonstrate source control by showing equivalent concentrations in groundwater downgradient of PAP Area as upgradient.

- The performance standard will be the MCLs or groundwater RBCs for arsenic, phosphorus and other COCs, as measured at appropriate Off-Plant locations. Where there is an MCL, the MCL shall control.

2.2.2 Groundwater Monitoring

The objective of groundwater monitoring is to collect sufficient data of adequate quality to evaluate the performance of the extraction system and other source control measures in reducing the extent and concentration of arsenic, phosphorus, and other COCs in groundwater in the Simplot OU and in preventing migration of arsenic, phosphorus and other COCs into the Off-Plant OU at concentrations above MCLs or groundwater RBCs (where there is an MCL, the MCL shall control). Specifically, components of the monitoring program will provide data to document the effectiveness of the extraction system in capturing seepage from the gypsum stack, to track water quality in areas potentially affected by sources other than gypsum stack seepage, and to confirm the attainment of performance standards and the long-term effectiveness of the remedy.

Performance standards for groundwater monitoring are as follows:

- Groundwater samples will be collected from wells on a quarterly basis for a period of five years and the samples analyzed for arsenic, phosphorus and other site related constituents. The specific wells to be monitored, the analytes, and the data evaluation procedures will be provided in the draft Groundwater Monitoring RDR.

- After the five-year period, the monitoring locations and frequency will be evaluated and monitoring will continue on at least a semiannual basis.

- Monitoring of Batiste Spring and other Off-Plant locations will be initiated on a quarterly basis at the time of system startup. After successful demonstration of compliance with the performance standard, samples will be collected semi-annually. The data evaluation procedures are provided in the draft Groundwater Monitoring RDR.

- The performance monitoring strategy shall provide a mechanism to identify when additional contingency actions are required, and shall measure progress toward achieving final groundwater RBCs as measured at the locations approved by EPA.

2.2.3 Surface Water Monitoring

The objective of surface water monitoring is to collect sufficient data of adequate quality to evaluate the performance of the groundwater extraction system and source control measures. A surface water monitoring plan has been submitted for EPA review and approval. The performance monitoring strategy shall provide a mechanism to identify when additional contingency actions are required, and shall measure progress toward achieving final surface water RBCs as measured at the locations approved by EPA.

The VCO/CA specifies the remedy goal of meeting the following concentration-based requirements in the Portneuf River as measured at Siphon Road:

- Achieve a 50 percent reduction (0.625 mg/L) in the concentration of total phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2013.

- Achieve a 75 percent reduction (0.938 mg/L) in the concentration of total phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2015.

- Achieve a 94 percent reduction (1.175 mg/L) in the concentration of total phosphorus in the Portneuf River as measured by the annual median of monthly samples collected at Siphon Road by December 31, 2021. This level equates to the water quality target of 0.075 mg/L established for total phosphorus for this segment of river as set forth in the approved TMDL.

The baseline condition determined by IDEQ is 1.250 mg/L as the annual median of monthly samples, based on data collected from 2004 to 2007.

3.0 BACKGROUND

The purpose of this section is to provide a summary of background information that is important to the design of the groundwater extraction and monitoring systems. This section is organized as follows:

- Section 3.1 provides a summary of previous work and the status of the current test extraction system and the groundwater monitoring system.
- Section 3.2 provides a detailed description of operations at the Simplot Facility including, waste management at the facility, and water management at the facility.
- Section 3.3 provides a description of the CSM for groundwater in the Simplot Plant Area. The CSM has been revised significantly based on the results of recent investigations. The CSM includes a description of the hydrogeologic setting, site-specific hydrogeology, Portneuf River hydrology, the nature and extent of groundwater contamination in the Simplot Plant Area, and a detailed evaluation of the fate and transport of site-derived constituents in groundwater.

3.1 Summary of Previous Work

3.1.1 Investigations

A RI was performed in accordance with the AOC for the RI/FS for the EMF Site, issued by the EPA in 1991, and entered into by FMC and Simplot. The RI was completed in 1996. The ROD was signed in 1998. A Remedial Design/Remedial Action Consent Decree with EPA for the Simplot Plant Operable Unit was signed by Simplot and entered in 2002. Simplot has since been in a phased process of designing and installing a groundwater extraction and monitoring system as required by the SOW. A test extraction system began operation in June 2004 (referred to herein as the phase 1 system) and additional test extraction wells were added to the system in 2007 (referred to herein as the phase 2 system). Quarterly groundwater monitoring has been performed since 2004 to establish baseline conditions (i.e., prior to extraction), evaluate the effect of the test extraction system on downgradient groundwater quality, and provide data to support the final extraction and monitoring system design. A groundwater geophysical investigation was performed in 2008 to aid in the delineation of site-derived constituents between Highway 30 and the Portneuf River. A subsurface investigation in the PAP Area was completed in April 2009. A summary of the scope of these investigations and references for investigation reports are provided in the following paragraphs.

<u>Remedial Investigation (Bechtel 1996)</u> - As part of the RI 109 soil borings were advanced and 35 monitoring wells were installed in the Simplot Plant Area in 1992, 1993 and 1994. Borings

that were not completed as monitoring wells were advanced to investigate areas which historic data and current plant operations indicated were most likely to have potential sources of releases or where placement of raw materials or by-products would have occurred (Bechtel 1996). Subsurface samples were collected and submitted to laboratories for analysis for both chemical and engineering properties. Borings were advanced to a depth of 10 feet or until groundwater or bedrock was encountered. Monitoring wells were installed at various locations and depths to delineate the extent of site-derived constituents in groundwater and investigate hydrologic properties of saturated materials.

<u>1996 Supplemental Investigation</u>: - Ten additional monitoring wells (336 through 345) were installed in August and September 1996.

<u>1998 Supplemental Investigation</u> - A monitoring well pair, one deep (well 347) and one shallow (well 340), were installed in July 1998 down gradient of the Don Plant Phosphoric Acid Plant. A deep monitoring well was installed in the West Plant Area.

<u>2002 – 2004 Remedial Design Investigations (MFG 2004)</u> – Additional investigations were completed to fill hydrogeologic data gaps, provide information for the design of a test extraction system, and install the initial test extraction system. Ten additional monitoring wells and The initial 10 test extraction wells were installed during these investigations. The fieldwork was initiated October 12, 2002 and completed April 28, 2004.

<u>Phase 1 Data Gap Investigation (NewFields 2006a)</u> – Two shallow test wells were completed adjacent to the existing shallow test extraction well 406 to investigate in shallow extraction well performance.

<u>Phase 2 Data Gap Investigation (NewFields 2008a)</u> – A series of multi-level monitoring wells and test extraction wells were installed to further investigate the extent of affected groundwater and the hydraulic properties in target capture areas. Four additional test extraction wells were installed.

<u>Groundwater Geophysical Investigation (NewFields 2008c)</u> – A surface resistivity survey was completed in the area between Highway 30 and the Portneuf River to assist in the delineation of site-derived constituents the groundwater in this area.

<u>Subsurface Investigation in the Phosphoric Acid Plant Area (NewFields 2008d, Simplot 2009)</u> - A series of 11 monitoring wells were installed within and immediately to the north of the PAP Area to investigate the geochemical properties of unsaturated and saturated subsurface solids and groundwater.

Data generated in these prior investigations are currently being used in the design of the groundwater extraction system.

3.1.2 Current Test Extraction System

Currently 14 test extraction wells are part of the test extraction system. The locations of the wells are shown in Figure 3-1.

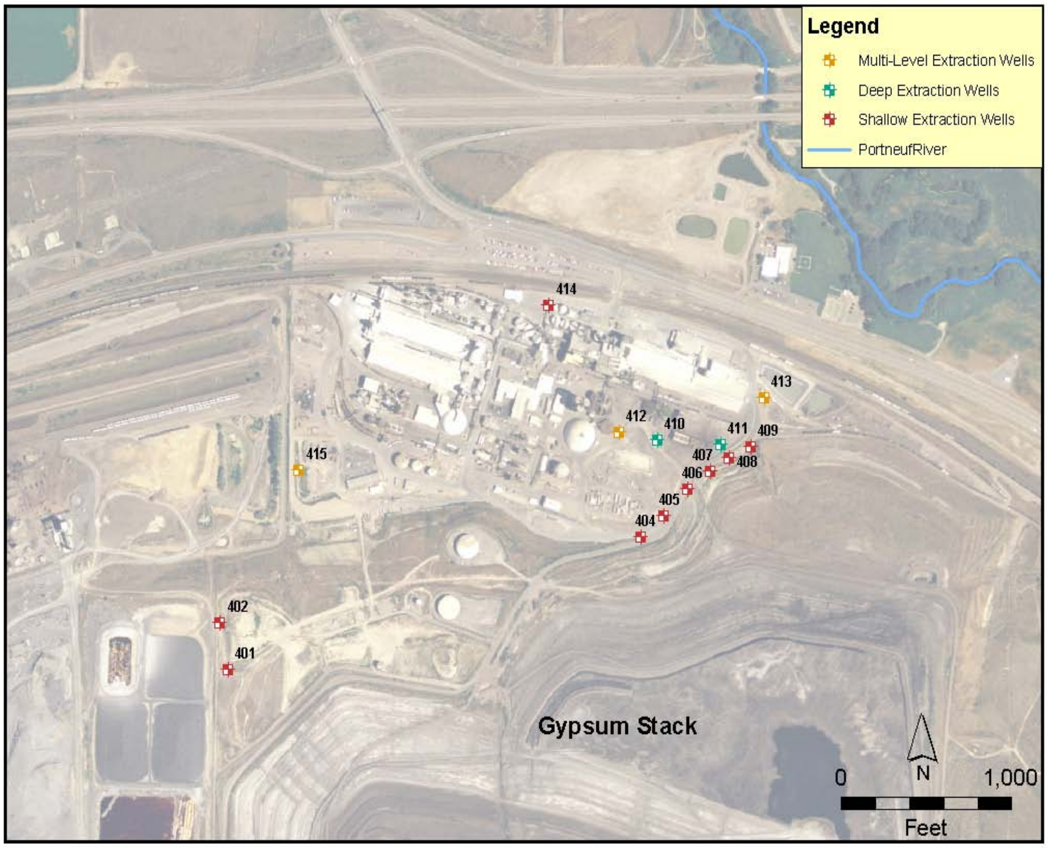

Figure 3-1: Extraction wells part of the current (2008) extraction system.

Wells 401, 402, and 404 through 411 were installed between 2002 to 2004 and brought on-line in the initial test extraction system (phase 1) in June 2004. Wells 412 through 415 (phase 2) were installed in 2007 and brought on-line in January 2008.

Reports on extraction well performance are prepared and submitted to oversight agencies quarterly.

3.1.3 Current Groundwater Monitoring System

There are currently (4^{th} quarter 2009) 137 monitoring locations included in Simplot's quarterly monitoring program. The monitoring system consists of 116 monitoring wells, 14 test extraction wells, 3 production wells, two spring locations (Batiste Spring and the Spring at Batiste Road) and 2 Portneuf River locations (at the Highway 30 bridge and at the Batiste Road bridge).

Groundwater levels are measured in all the wells except for the production wells and at the two river locations. Water quality samples are collected from the 14 test extraction wells, the 3 production wells, two spring locations, and 70 of the monitoring wells.

Reports on groundwater monitoring results are prepared by Simplot and submitted to oversight agencies quarterly. Comprehensive reports on groundwater monitoring and extraction system performance are also submitted annually. All groundwater monitoring data are placed in a database that is posted on the project website (www.FormationEnv.com/Simplot_EMF/).

3.2 Simplot Don Plant Operations

The Simplot Don Plant produces phosphoric acid from phosphate ore using a wet (aqueous) process. Phosphate ore was formerly transported from the Gay, Conda, and Smoky Canyon mines to the plant via railcar. As of September 1991, the Simplot plant began receiving phosphate ore through a slurry pipeline solely from the Smoky Canyon mine.

In preparation for transport, the phosphate ore is crushed and beneficiated (physically washed) at the Smoky Canyon phosphate mining/processing plant. Fine and coarse materials generated from the crushing process are separated in sequence by classifiers and a hydroclone system. The beneficiation process yields a 26 to 31 percent equivalent phosphorus pentoxide (P_2O_5) concentrate suitable for production of phosphoric acid at current process recovery. The slurry is transported to the Don Plant through the buried pipeline.

Upon arrival at the plant, the slurried phosphate ore is thickened to approximately 70 percent solids content before being stored in agitated tanks. It is pumped directly into the phosphoric acid reactor from the storage tanks. The phosphoric acid is further processed into a variety of solid and liquid fertilizers. The plant is an integration of several different processing units, each unit producing either an intermediate or final product.

3.2.1 Wastes and By-Products

The gypsum produced from the phosphoric acid process is slurried (25 to 30 percent solids) and pumped to the top of the gypsum stack. Process water used to slurry the gypsum to the stack is decanted (i.e. pumped) off the stack in high-density polyethylene (HDPE) pipes after the solid gypsum settles.

Aqueous laboratory wastes (i.e., acids, ammonia, and sodium hydroxide) are treated in a dedicated elementary neutralization unit (ENU) and discharged to the City of Pocatello’s treatment facility (a Publicly Owned Treatment Works (POTW)).

Nutrient-rich noncontact water and storm water treated in the series of three lined ponds, north of the plant between Highway 30 and the Portneuf River, have been sold for irrigation/fertilization since July 1980 under a joint land-application permit with the City of

Pocatello. Prior to July 1980, the treated water was discharged to the Portneuf River (NPDES Permit ID000067). The City ceased discharging POTW outfall to the land application system in 2004 and transferred operation, maintenance, and permit conditions to Simplot for the entire land application program. In October 2006, Simplot applied to IDEQ for renewal of all permits associated with the joint agreement and requested all permits for the program be assigned to Simplot.

The EPA funded the Joint Waste Treatment Feasibility Study, Project EPA P0000080-03, which evaluated effluent handling alternatives available to the Pocatello Sewage Treatment Plant and local industries. The study evaluated the suitability of wastewaters for irrigation, including characteristics of nutrient level, salinity, organic loading, sodium absorption ratio, and trace elements. The trace elements evaluated included aluminum, arsenic, boron, cadmium, chromium, cobalt, copper, fluoride, iron, lead, manganese, nickel, selenium, and zinc. The recommendations from the study in Report No. 219 concluded that "the EPA and the State Division of Environment should, where possible, assist and encourage the City of Pocatello and J.R. Simplot Company toward the completion of the land application project. Implemented by: Idaho Department of Health and Welfare and EPA." The recommendation was given force by an EPA AOC in 1978.

Under the AOC, Simplot chose to eliminate discharges to the Portneuf River by land application of the nutrient-rich water under the State of Idaho Land Application permit system. In 1992, a permit was issued to Simplot and the City of Pocatello for operation of part of the system (Land Application No. LA-000104, 8/17/92).

A comparison of analytical data for Simplot's irrigation water with the EPA's land-application limits for wastewater shows that the concentrations of the various inorganic compounds are considerably below the EPA-recommended concentration limits.

3.2.2 Waste Management

There are two gypsum stacks on the facility grounds south of the plant operating areas. The original gypsum stack is the northernmost of the two stacks. The southernmost stack has been in use since 1966. Together, the two gypsum stacks occupy an area of approximately 340 acres. Simplot is in the process of raising the level of the lower, northernmost stack and merging the two stacks into one.

As previously discussed, a series of lined ponds, north of the plant between Highway 30 and the Portneuf River, is used to collect the non-contact water and storm water. These water streams are collected by a facility drainage system and flow through a pipe under Highway 30 into an ENU for pH adjustment, if needed, or into a lined "equalization" pond. Water that flows to the equalization pond is combined with other water streams at the equalization pond that do not require pH adjustment. The equalization pond liner is constructed of clay, bentonite, and compacted soil to which a chemical sealant has been added. Equalization pond water is pumped to a large lined surge pond located north of Interstate 86 for storage prior to being used for irrigation and fertilization. The surge pond liner construction is the same as that of the equalization pond.

3.2.3 Water Balance

3.2.3.1 General Don Plant Facility Water Balance

The Don Plant water balance is dynamic and complex and is critical to successful facility operation. Numerous unit operations require different water flows and have different minimum water quality requirements. For example, boiler feed water must have relatively low dissolved solids content, whereas water used in the phosphoric acid cooling process has essentially no requirements for water quality. Flows are continuously measured at key points within the process as part of routine operation and have been reported to EPA on a monthly basis.

- Production Wells Fresh water is pumped from three production wells (SWP-4, SWP-5 and SWP-7). Flows are measured continuously at SWP-5 and SWP-7 and at various downgradient locations. Flows from SWP-4 are calculated from the total downgradient flows and the other production well flows.

- Phosphoric Acid Plant Fresh water requirements in the PAP are driven by process conditions including production rate and associated cooling needs. Flows are measured at four different locations in the PAP and the total flow is reported.

- Extraction Wells Extraction well flows are recycled back to the PAP process, replacing a portion of fresh water. Flows are measured continuously for each extraction well.

- Water Flows to Gypsum Stack Phosphogypsum is slurried to a range of 28 to 32 percent solids and pumped to the gypsum stack. Effluent water from the PAP unit operations (such as scrubber water blowdown and reclaim cooling system blowdown) is used as needed to maintain the required solids content. The slurry density, solids content, and total flow are measured continuously at the gypsum thickeners. The water flow is calculated based on the data collected and the density of gypsum.

- Gypsum Stack Decant Return Water ponds on the top of the gypsum stacks as the gypsum solids settle out and the ponded water is “decanted” [or pumped] back to the process. Stack panel dykes are continuously built with the settled gypsum solids. The decant water is pumped from the ponded area back to the reclaim cooling system. The flow rate is set by the operators on an as-needed basis.

A summary of the average flows per quarter since 2003 is shown in Table 3-1 and Figure 3-2. Average annual flows are shown in Figure 3-3. Monthly summary reports for the last year of operations are included in Appendix A.

Table 3-1: Don Plant Water Flow Summary.

	Production Well Flows (gpm)				Average PAP Area Fresh Water Consumption (gpm)	Superfund Extraction Well Flows (gpm)	Gypsum Stack Flows (gpm)	
Quarter	SWP-4	SWP 5	SWP 7	Total			Water Flow to Gypsum Stack	Water Returned From Stack via Decant Line
2003								
Q1	1,456	1,608	1,151	4,215	2,203	192	3,554	724
Q2	1,129	1,692	1,044	3,865	2,074	18	3,383	893
Q3	1,333	1,567	1,188	4,088	2,037	0	3,503	953
Q4	1,436	1,236	1,095	3,767	1,779	0	3,680	771
2004								
Q1	1,617	1,290	1,100	4,006	2,003	19	3,537	794
Q2	1,567	1,164	1,030	3,761	1,934	268	3,272	704
Q3	1,781	1,396	1,096	4,273	2,122	232	3,245	638
Q4	1,673	1,280	1,138	4,091	2,011	347	3,437	649
2005								
Q1	1,565	1,019	1,399	3,982	2,013	362	3,744	918
Q2	1,375	1,127	1,149	3,651	1,712	281	3,337	1,019
Q3	1,657	1,226	1,271	4,154	1,988	307	3,436	938
Q4	1,618	1,077	1,114	3,808	1,824	344	3,325	646
2006								
Q1	1,478	999	1,123	3,600	1,731	341	3,511	776
Q2	1,262	1,076	1,060	3,398	1,550	302	3,234	908
Q3	1,168	1,587	1,163	3,918	1,782	349	3,282	760
Q4	1,124	1,528	1,196	3,848	1,722	356	3,364	708
2007								
Q1	1,260	1,501	1,235	3,996	1,938	287	3,438	813
Q2	1,128	1,442	1,102	3,672	1,686	214	3,246	986
Q3	1,355	1,655	1,198	4,209	2,079	230	3,375	796
Q4	1,208	1,427	1,189	3,823	1,751	282	3,691	773
2008								
Q1	1,097	1,311	1,392	3,800	1,675	547	3,457	592
Q2	746	1,301	1,373	3,421	1,554	565	3,369	761
Q3	770	1,368	1,355	3,493	1,469	778	3,442	714
Q4	766	949	1,340	3,055	1,310	807	3,168	441
2009								
Q1	1,087	718	1,043	2,848	1,172	823	3,748	794

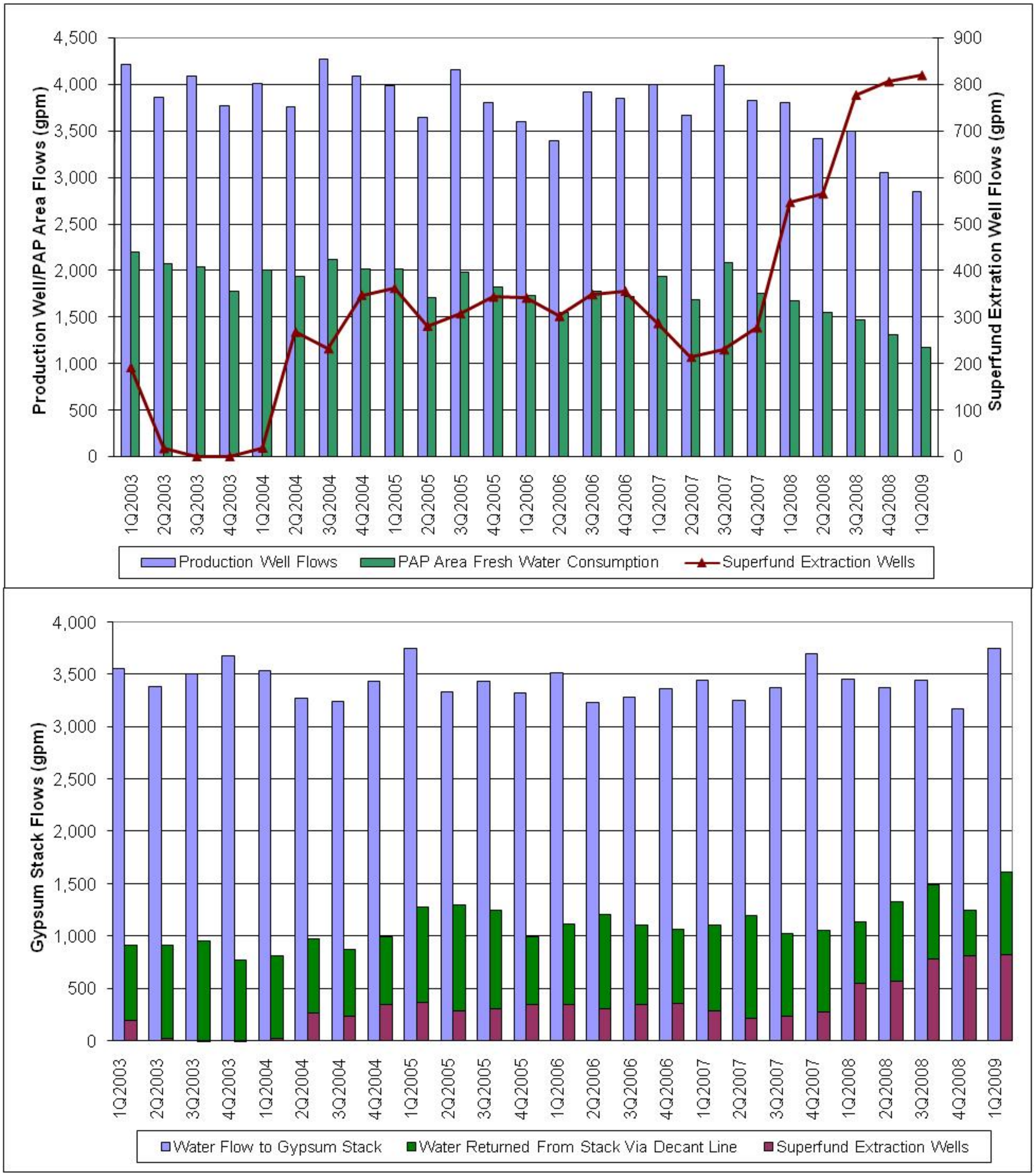

Figure 3-2: Average Quarterly Plant Flows.

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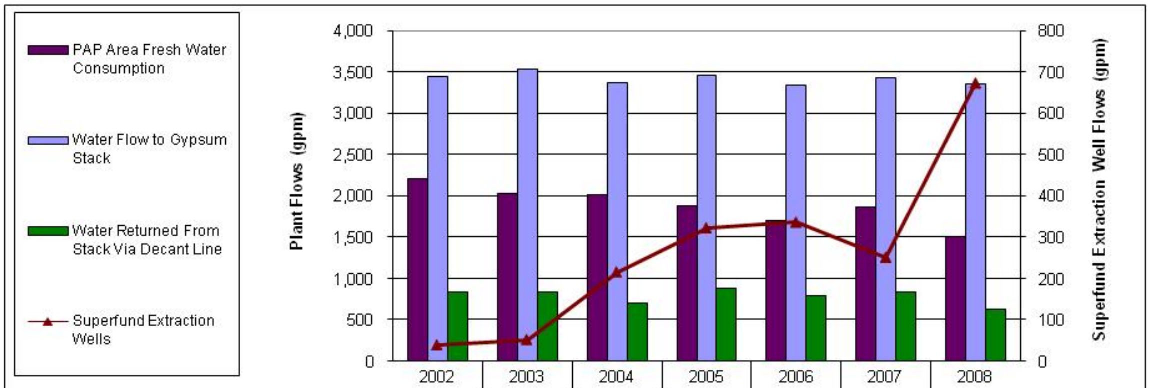


	2002	2003	2004	2005	2006	2007	2008
PAP Area Fresh Water Consumption	2,215	2,023	2,017	1,884	1,696	1,864	1,502
Water Flow to Gypsum Stack	3,447	3,530	3,373	3,461	3,348	3,438	3,359
Water Returned From Stack Via Decant Line	834	835	696	880	788	842	627
Superfund Extraction Wells	39	52	216	323	337	252	674

Figure 3-3: Average Annual Plant Flows, 2002 – 2008.

Three production wells pump fresh water from the lower aquifer (Lower Zone) in the northern portion of the Don Plant. Average quarterly production well flows are shown in Table 3-1. Flows have decreased in response to ongoing water balance optimization activities and with the increase of extraction well production. Water also comes in with the ore slurry (approximately 200 gallons per minute). Major water outputs from the Don Plant facility are: 1) Contained in the slurry sent to the gypsum stack (approximately 3,450 gallons per minute, with approximately 750 gallons per minute returned to the phosphoric acid plant via the decant line), 2) Loss through the gypsum stack (approximately 900 gallons per minute); 3) Water stored prior to sale as irrigation water (approximately 650 gallons per minute), 4) Emissions to atmosphere including steam and evaporation; and 5) Contained in products.

3.2.3.2 Gypsum Stack Water Balance

The gypsum stack has three separate cells: the lower stack and the eastern and western cells on the upper stack. At the time of the RI, Simplot was using the upper stack only. The lower stack (which had been used historically) was returned to service around 1994 and gypsum slurry was applied to each of the cells in turn on a schedule of approximately six weeks. In the summer of 2008 the lower stack was again removed from service in preparation for the placement of a liner on this stack.

Monthly reports summarizing water use in the plant and the water flows within the gypsum thickener operation has been provided to the oversight agencies. Water lost to infiltration can be calculated using the measured flows to the stack and decant water returned to the Don Plant process, estimating the water incorporated into the gypsum as water of hydration and water retained as moisture within the gypsum, and estimating the amount of water evaporated from the stack. Based on the data collected from 2002 to 2004, the gypsum stack slurry had a solids content of approximately 30% by weight, a resulting total water flow of approximately 3,450 gallons per minute, and a decant water return of about 760 gpm. Data collected from August 2007 through September 2008 indicate that the gypsum stack slurry has a solids content of approximately 25% by weight, a resulting total water flow of approximately 3,450 gallons per minute, and a decant water return of about 715 gpm. Using this information and accounting for evaporation, the amount of water seepage lost through the gypsum stack and into the groundwater system can be calculated. A calculation of the gypsum stack water balance based on average measurements from January 2002 through September 2004 in included in Appendix A. Calculations indicate that about 850 to 900 gpm of water is lost to infiltration. A summary of the calculation presented in Appendix A is as follows:

Total gypsum slurry flow	=	3834 gpm
Total water in gypsum slurry (72% by weight)	=	3462 gpm
Decant water returned	-	759 gpm
Water retained as residual moisture in gypsum	-	335 gpm
Cooling evaporation	-	239 gpm
Pond evaporation	-	287 gpm
Damp gypsum evaporation	-	934 gpm
		908 gpm

Currently more water is present on the stack and is pumped back from the stack to the facility than in previous periods. It is believed that since the calciners ceased operation in 1991, the resultant gypsum has a lower permeability and less water is seeping directly through the stack. This is evidenced by increased ponding on the stack and increased direct pump back from the stack to the facility.

3.3 Conceptual Site Model for Groundwater

The conceptual site model (CSM) for groundwater is described in this section. The description is intended to be comprehensive for the purposes of the design of the groundwater extraction and monitoring systems. This CSM description is divided into the following sections:

1. Regional Hydrogeologic Setting

2. Site-Specific Hydrogeology

3. Surface Water – Groundwater Interaction

4. Nature and Extent of Site-Derived Constituents

5. Fate and Transport of Site-Derived Constituents

3.3.1 Hydrogeologic Setting

The Simplot Plant Area of the EMF Site is located at the base of the northern slope of the Bannock Range and along the western flank of the Portneuf Valley, where the range and river valley merge with the Snake River Plain in the area known as Michaud Flats (Figure 3-4). The southern portion of the Simplot Plant Area, which includes the gypsum stacks, is located on the northern flank of the Bannock Range. The northern portion of the Simplot Area, which includes the holding ponds north of Highway 30, is located in the eastern portion of Michaud Flats adjacent to the Portneuf River. The central portion of the facility, where most of the plant facilities are located, is at the base of the Bannock Range where subsurface deposits represent a combination of materials derived from range erosion and materials deposited by the Portneuf River.

The geology and hydrogeology of the Bannock Range, Portneuf Valley, and Michaud Flats have been described by previous investigators (West and Kilburn 1963, Trimble 1976, Jacobson 1984, Spinazola and Higgs 1998, and Othberg 2002). A comprehensive discussion of regional and site-specific geology and hydrogeology is presented in the RI report. A summary of the hydrogeologic setting pertinent to the design of the groundwater extraction and monitoring systems in the Simplot Plant Area is provided in the following paragraphs. For reference, three north-south geologic cross sections are provided in Figures 3-5, 3-6 and 3-7.

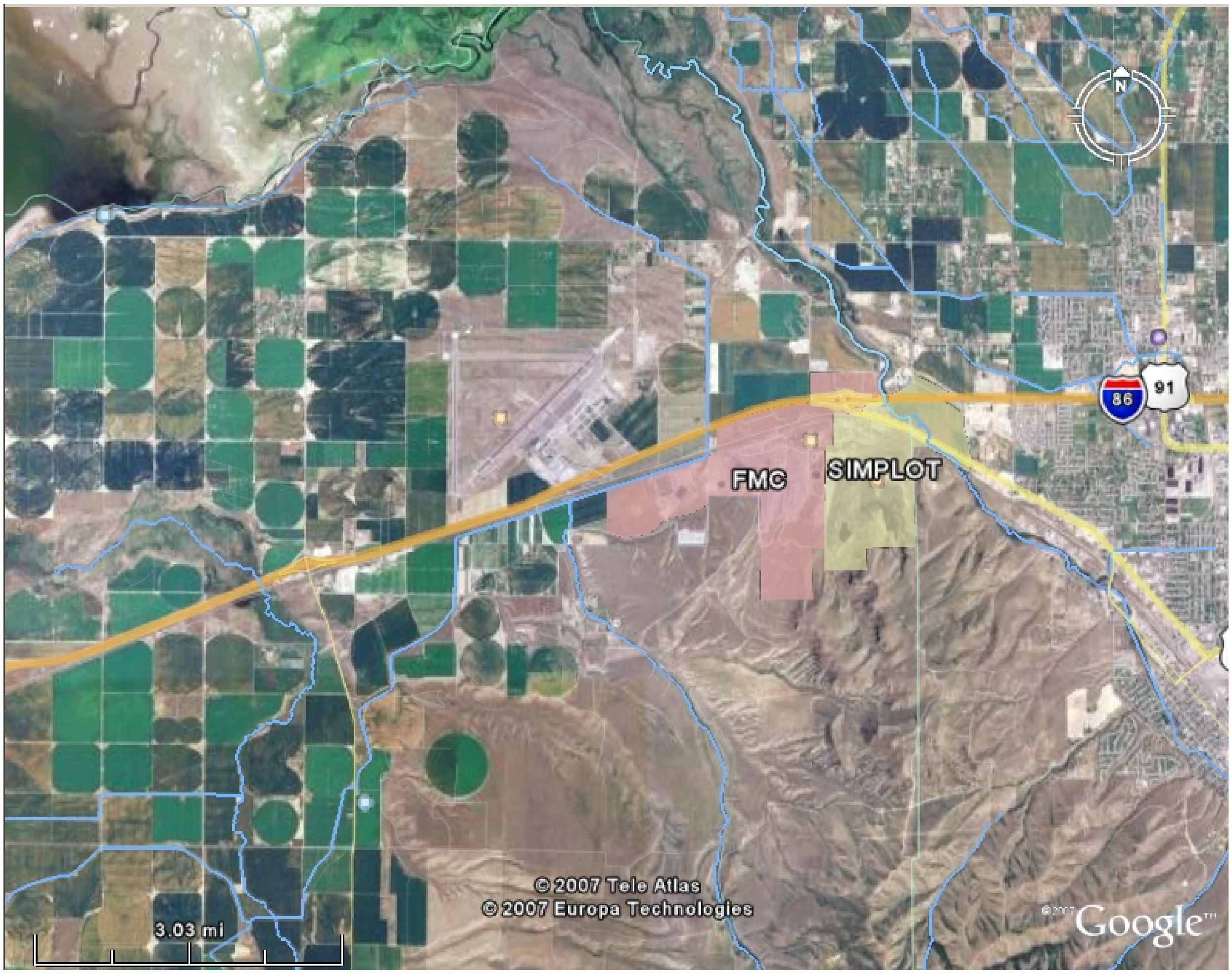
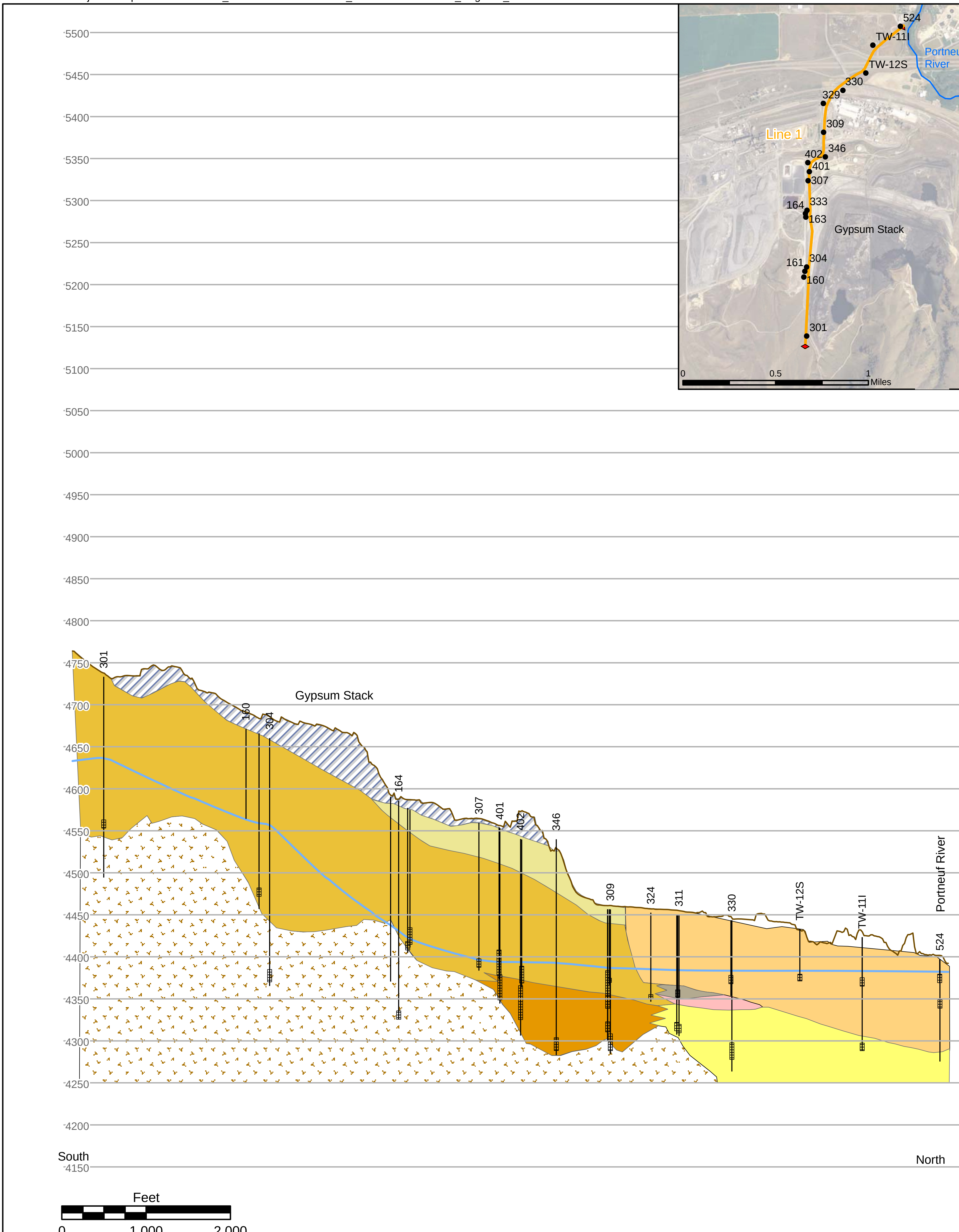


Figure 3-4: Physiographic setting



Legend

- Wells within 150 feet
- Well Screen
- Upper Zone Groundwater (8/03)
- Ground Surface (2008)

Geologic Unit

- Qbh
- Fill
- Qal
- Qcb
- Ql
- Qm
- Qam
- Qfg
- Qfgw
- Qf
- Qsu
- Tsu
- Tsup
- Tsur

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EASTERN MICHAUD FLATS

FIGURE 3-5

REGIONAL CROSS SECTION 1

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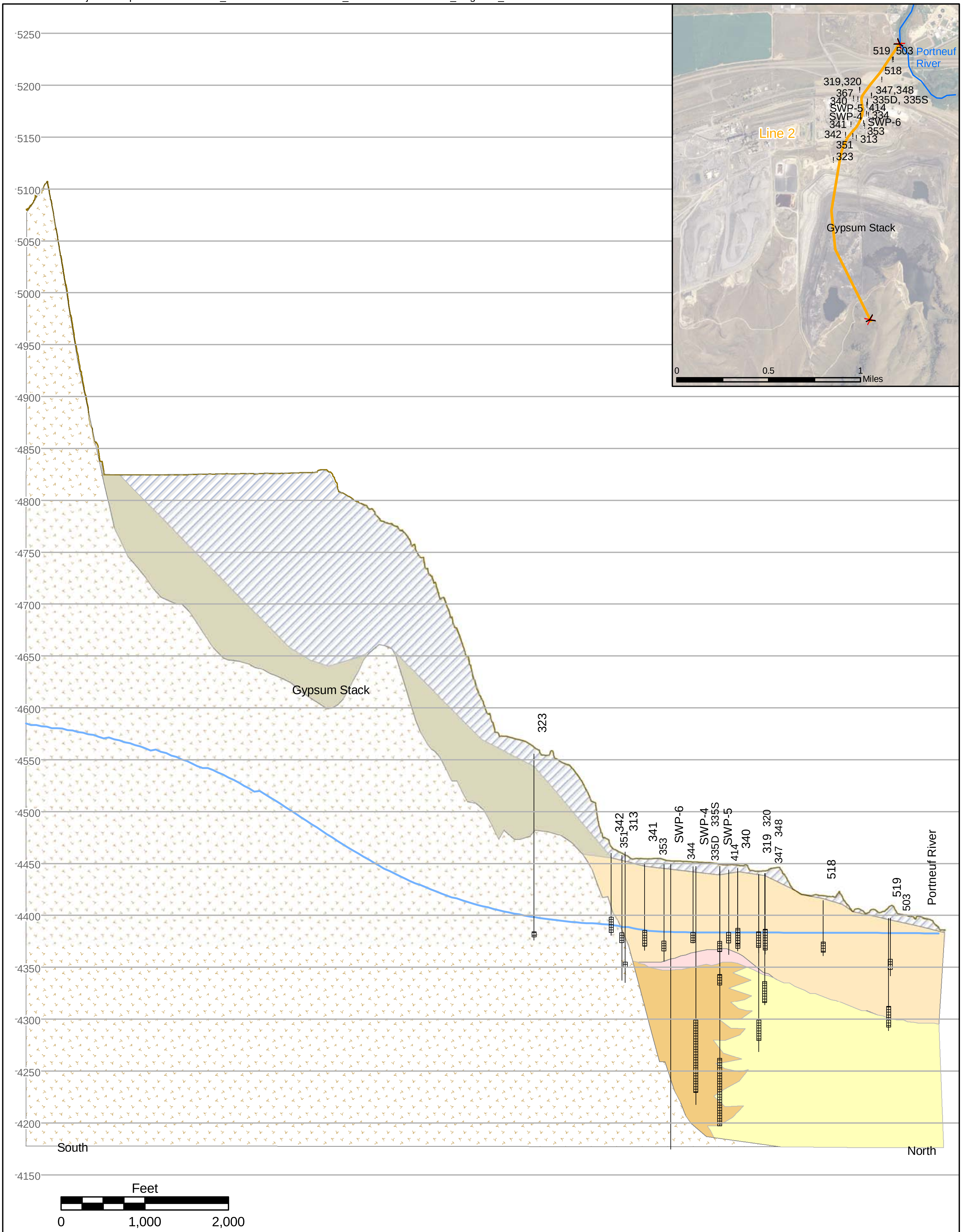

Legend

- Wells within 150 feet
- Well Screen
- Upper Zone Groundwater (8/03)
- Ground Surface (2008)

Geologic Unit

- Qbh
- Fill
- Qal
- Qcb
- Ql
- Qm
- Qam
- Qfg
- Qfgw
- Qf
- Qsu
- Tsu
- Tsup
- Tsur

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EASTERN MICHAUD FLATS

FIGURE 3-6

REGIONAL CROSS SECTION 2

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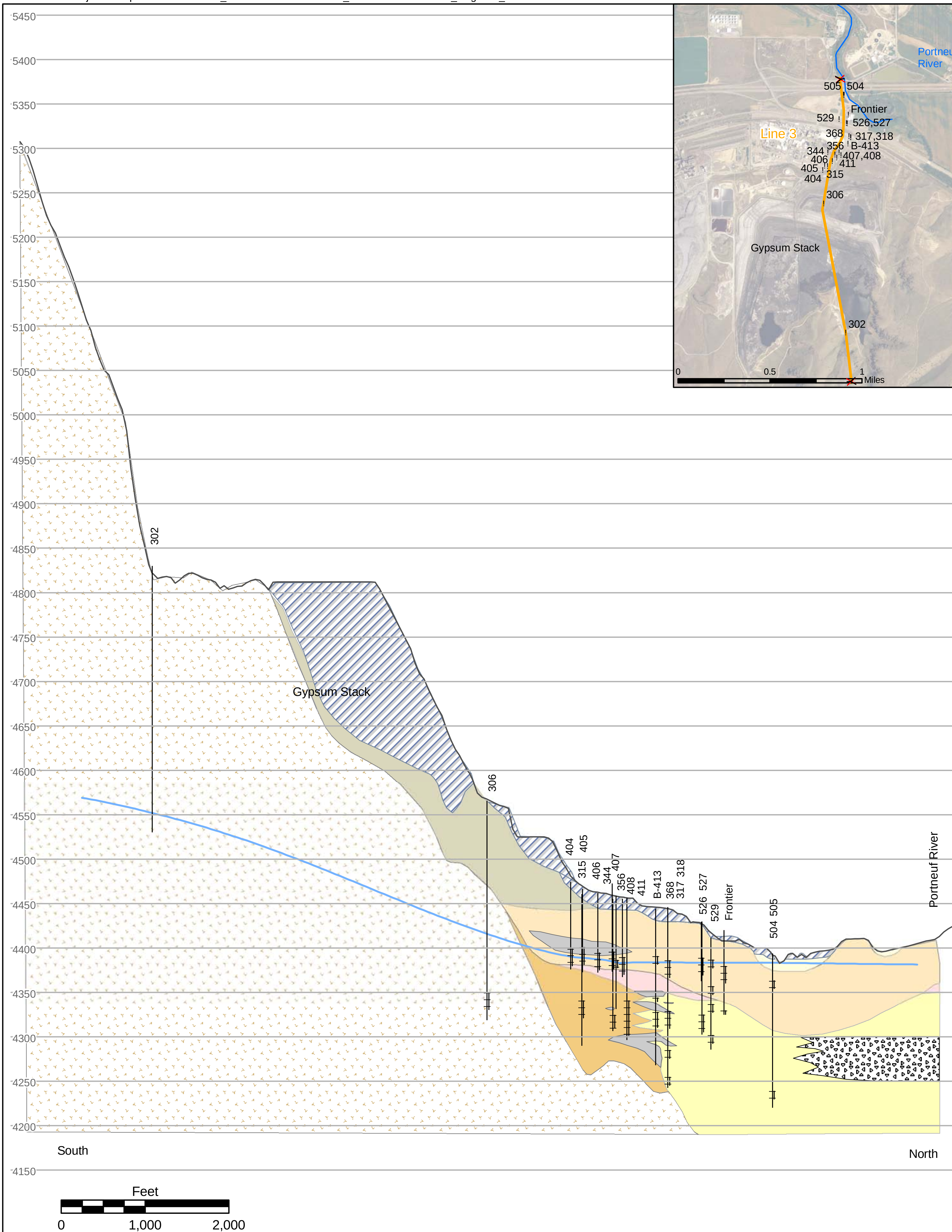

Legend

- Wells within 150 feet
- Well Screen
- Upper Zone Groundwater (8/03)
- Ground Surface (2008)

Geologic Unit

- Qbh
- Fill
- Qal
- Qcb
- Ql
- Qm
- Qam
- Qfg
- Qfgw
- Qf
- Qsu
- Tsu
- Tsup
- Tsur

J.R. SIMPLOT

EASTERN MICHAUD FLATS

FIGURE 3-7

REGIONAL CROSS SECTION 3

PJT: #0442-002-900	Jul 08, 2009	
REV: 0	BY: TRA	CHECKED: BC

FORMATION ENVIRONMENTAL

3.3.1.1 Southern Portion of Simplot Area

Geology

The southern portion of the Simplot Area is located on the northern flank of the Bannock Range. The geology in this area consists of the Tertiary Starlight Formation mantled by varying thicknesses of alluvial fan gravel (Qfg) and loess/colluvium (Qcb).

The Starlight Formation is a volcanic formation that has been divided into three units by Trimble (1976). The upper portion of the upper member (Tsup) consists of a porphyritic trachyandesite flow. This unit forms the prominent cliffs that rise above the gypsum stack to the south. The formation dips to the north at about 20-30^{o} and the trachyandesite unit continues into the subsurface beneath the Simplot Plant Area and further to the north. The trachyandesite member is continuous beneath the gypsum stack, but has been thinned in areas where incised by stream erosion. The trachyandesite is underlain by a vitrophyre (volcanic glass) that is present in some areas followed by rhyolite tuff and basalt. These portions of the upper member have been observed at depth in borings in the southwestern portion of the Simplot Plant Area. The middle and lower members of the Starlight Formation have not been encountered in the Simplot Plant Area since they occur at depths greater than have been investigated. A structure contour map of the Starlight Formation is shown in Figure 3-8. The top of the Starlight Formation represents an erosional surface with several incised channels.

The alluvial fan gravel (Qfg) generally consists of angular clasts of volcanic material derived from the upper member of the Starlight Formation (Tsup) and has a high clay and silt content. These deposits are thickest in the valley and paleo-valleys that were incised into the Starlight Formation. The deposits thicken to the north then interfinger with alluvial deposits in the Michaud Flats and pinch out.

Wind-blown and redeposited loess that mantles, interfingers with, or is mixed with stony colluvium derived from local bedrock (Qcb) directly overlies the Starlight Formation in most areas along the northern flank of the Bannock Range. The loess also overlies and interfingers with the alluvial fan gravel (Qfg). In some areas beneath the gypsum stack, the loess/colluvium has accumulated to thicknesses of over 100 feet.

Hydrogeology

The Bannock Range highland receives more precipitation than surrounding low-lying areas due to orographic effects and acts as a regional hydrologic recharge area. Wells completed in the Starlight Formation in the southern portion of the gypsum stack during the RI did not encounter the water table indicating that groundwater flow beneath the gypsum stack occurs as unsaturated flow. Groundwater flow potential in the unsaturated zone is vertically downward, but actual flow paths are likely influenced by the presence of preferential zones of higher hydraulic conductivity in the Starlight Formation.

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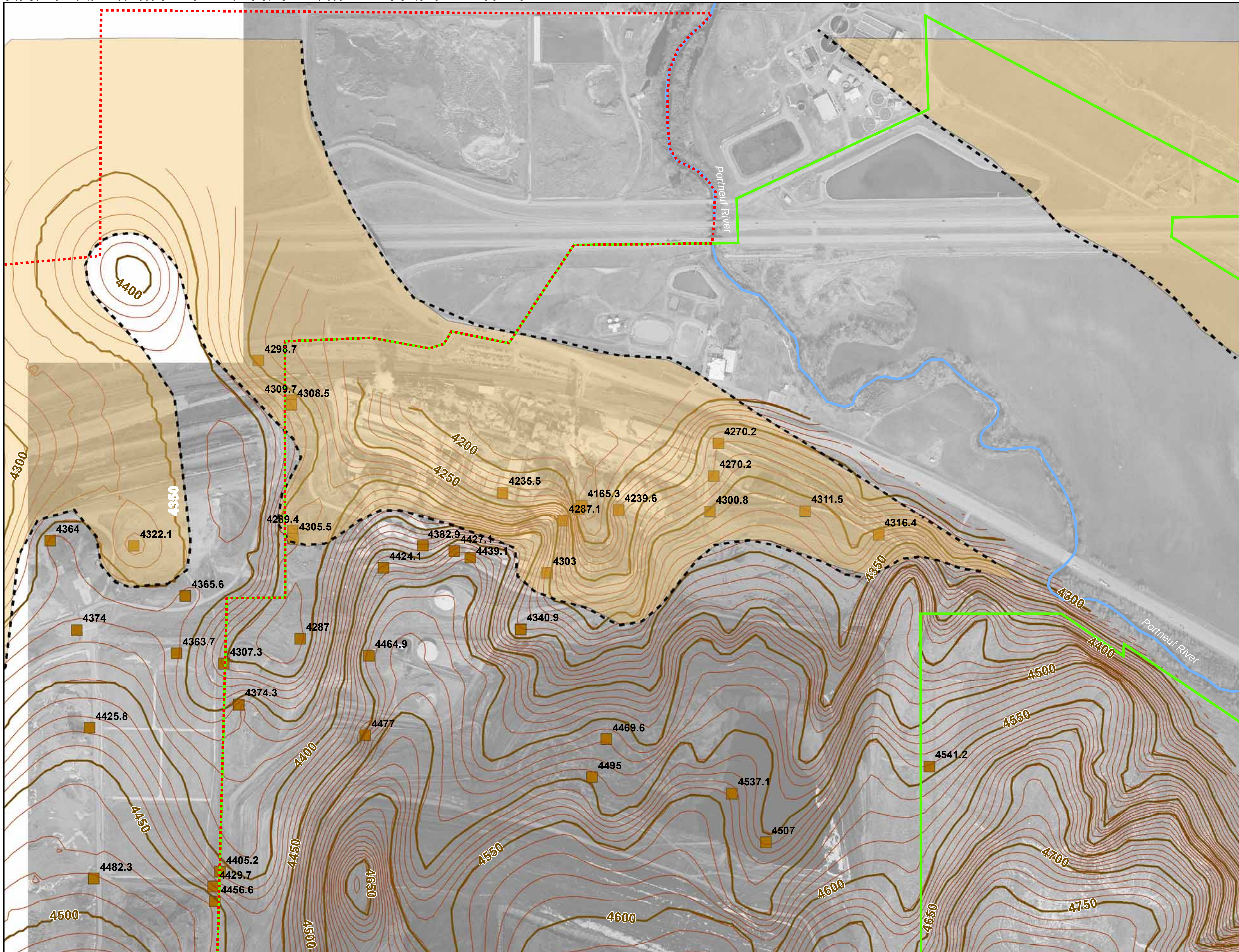

Legend

- FMC
- SIMPLOT
- Portneuf River
- AFLB Limit
- Estimated extent of AFLB
- Bedrock Elev 50 ft
- Bedrock Elev 10 ft
- Borings Encountering Bedrock

Aerial Photo: March 3, 2008

N

Feet

0 600 1,200

J.R. SIMPLOT

EASTERN MICHAUD FLATS

FIGURE 3-8

STRUCTURE CONTOUR MAP ON THE TOP OF THE TERTIARY STARLIGHT FORMATION

PRJ: 0442-002-900	NOV 4, 2008	
REV: 0	BY: MCP	CHK: BC

FORMATION ENVIRONMENTAL

3.3.1.2 Northern Portion of Simplot Area

Geology

The northern portion of the Simplot Plant Area is located in the eastern portion of Michaud Flats. The geology in this area consists of (from the surface downward) the Michaud Gravel (Qm), the American Falls Lake Beds (Qam), the Sunbeam Formation (Qsu), and the Big Hole Basalt (Qbh).

The Sunbeam Formation (Qsu) includes mostly coarse gravel deposits associated with the Portneuf Valley. These gravels primarily comprise quartzite and other quartz-rich metamorphic lithologies. The upper portion of the formation is defined by the American Falls Lake Beds (Qam). The Cedar Butte Basalt dammed the Snake River near American Falls, forming an ancient lake that extended up to the Bannock Range foothills in the EMF area (Stearns et al., 1938). The ancient lacustrine sediments were named the American Falls Lake Beds by Carr and Trimble (1963) and are mostly clay with minor silt, sand, and localized gravel.

About 15,000 years ago, a catastrophic flood from ancient Lake Bonneville in northern Utah flowed down the Portneuf River Valley onto the Snake River Plain and into the basalt-dammed lake (Scott et al., 1982; Houser, 1992). The flood waters filled the ancient basalt-dammed lake, then flowed over the Cedar Butte Basalt lava dam breaching the dam. The flood deposited extremely coarse-grained sediments of the Michaud Gravel (Qm) along the Portneuf River Valley and into the Michaud Flats (Trimble and Carr, 1961). In the process, the flood scoured away the American Falls Lake Beds where the Portneuf Valley meets the Snake River Plain (Figures 3-9 and 3-10). The Michaud Gravel consists of mostly quartzite and other quartz-rich metamorphic lithologies with minor basalt. Sediment can be exceptionally coarse in the flood channels; quartzite and basalt boulders up to 8 feet (2.5 m) in diameter occur in downtown Pocatello (Trimble, 1976).

Hydrogeology

The Michaud Flats are underlain by productive basalt and gravel aquifers. These aquifers are recharged by underflow from the adjoining Bannock and Pocatello mountain ranges and from significant down valley underflow from the Pocatello Valley aquifer. The aquifer system can be divided into a shallow aquifer and a deeper aquifer. The shallow aquifer is the Michaud Gravel which is typically overlain by a silt aquitard, but is locally unconfined. The deeper aquifer is comprised of the gravel of the Sunbeam Formation, and volcanics of the Big Hole Basalt. The deeper aquifer is the primary water-producing aquifer within the Michaud Flats. The deeper aquifer is a confined system that underlies the American Falls Lake Beds, the regional aquitard between the shallow and deeper aquifers (Houser, 1992). In the northern portion of the Simplot Area, the American Falls Lake Beds are absent and no vertical barrier is present between the shallow and deeper aquifers. In the site-specific terminology that has been adopted, the shallow aquifer is called the Upper Zone, and the deeper aquifer is called the Lower Zone.

This northern portion of the Simplot Plant Area is situated in a regional discharge zone. Groundwater that flows into the regional aquifer system discharges to the Portneuf River (via springs and base flow contribution), American Falls Reservoir, or to one of the numerous springs and seeps in the Fort Hall Bottoms. Agricultural, industrial, and domestic water supply wells extract groundwater from the regional aquifer. Groundwater discharges to the Portneuf River along the reach from I-86 downstream to the American Falls Reservoir. The river gains approximately 200 cfs along this reach as groundwater discharges through the riverbed and springs.

The hydrogeology of the northern portion of the Simplot Plant Area has been investigated in detail in previous site-specific investigations. After the completion of the RI, this area was identified as an important area for monitoring groundwater conditions downgradient of potential EMF Site sources. Additional investigations have since been conducted in this area to fill data gaps necessary for the completion of the groundwater monitoring system Results of these investigations are included in the discussion of site-specific hydrogeology in Section 3.3.2.

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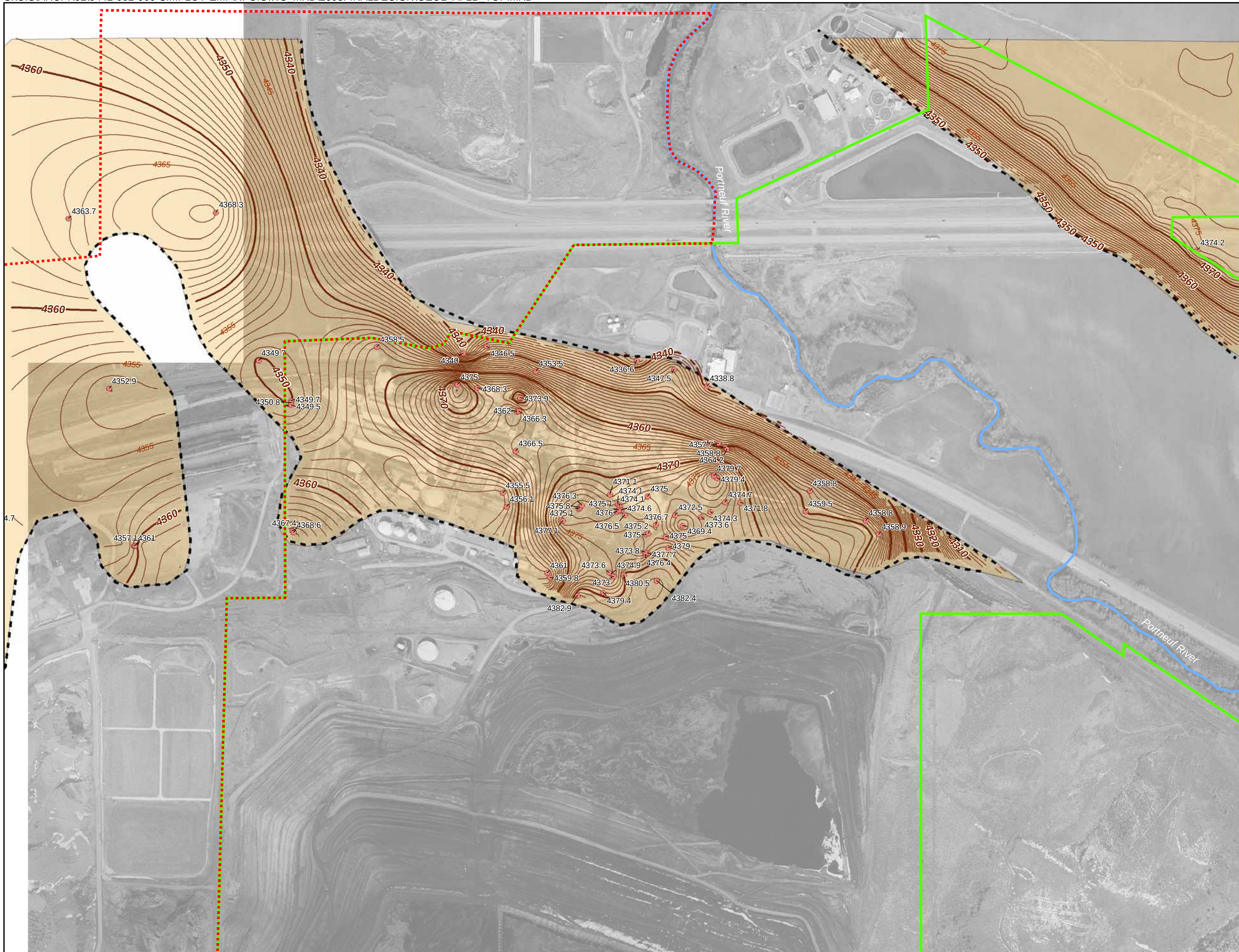

Legend

- FMC
- SIMPLOT
- Portneuf River
- Top AFLB
- Top of AFLB (ft) Index contour
- Top of AFLB (ft) contour
- AFLB Limit
- Estimated extent of AFLB

Aerial Photo: March 3, 2008

N

Feet

0 600 1,200

J.R. SIMPLOT

EASTERN MICHAUD FLATS

FIGURE 3-9

STRUCTURE CONTOUR MAP ON TOP OF THE AMERICAN FALLS LAKE BED (Qam)

PRJ: 0442-002-900	NOV 4, 2008	
REV: 0	BY: MCP	CHK: BC

FORMATION ENVIRONMENTAL

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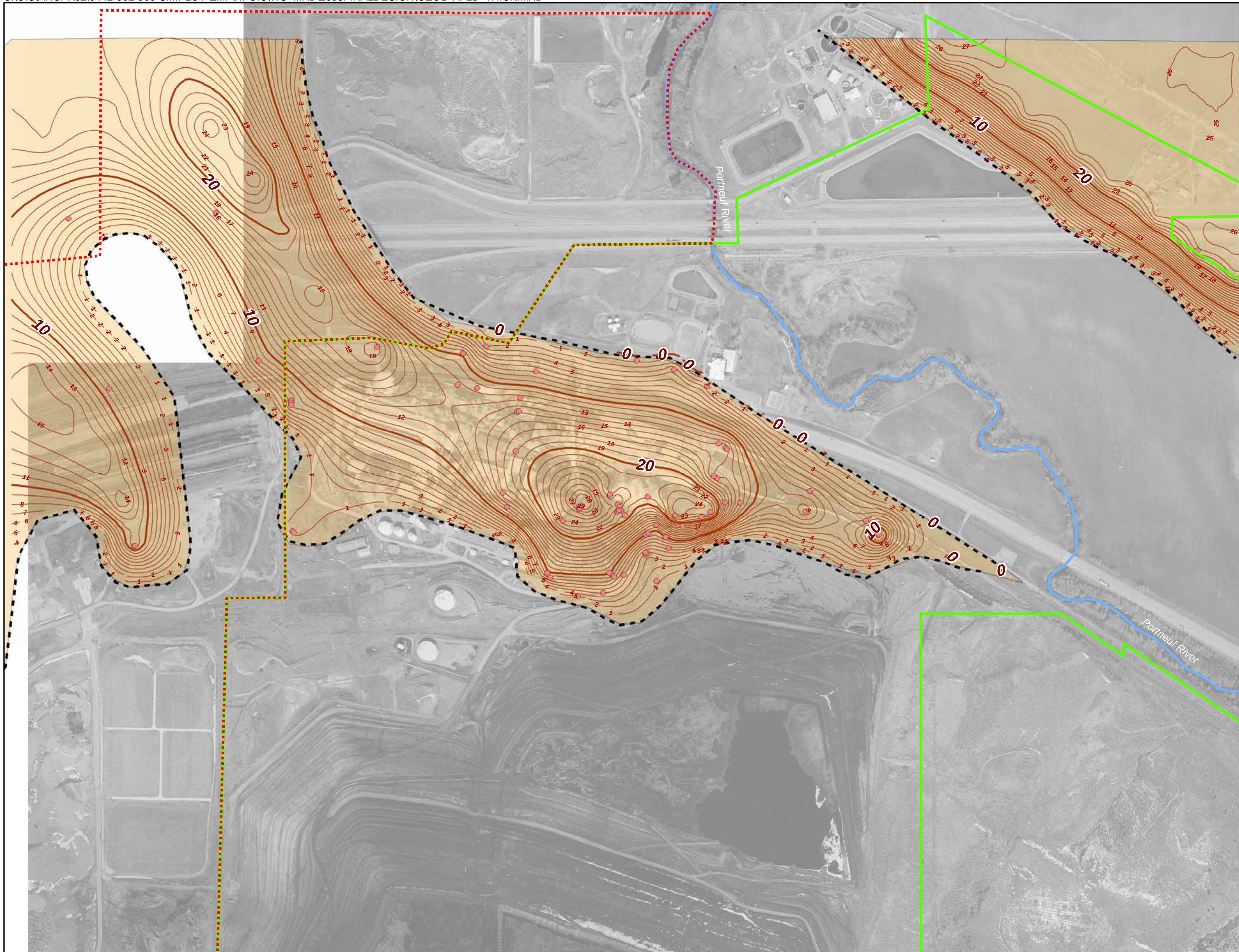

Legend

- FMC
- SIMPLOT
- Portneuf River
- Top AFLB
- AFLB Thickness (ft) Index contour
- AFLB Thickness (ft) contour
- AFLB Limit
- Estimated extent of AFLB

Aerial Photo: March 3, 2008

N

Feet

0 600 1,200

J.R. SIMPLOT

EASTERN MICHAUD FLATS

FIGURE 3-10

THICKNESS OF THE AMERICAN FALLS LAKE BED (Qam)

PRJ: 0442-002-900	NOV 4, 2008
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FORMATION ENVIRONMENTAL

3.3.1.3 Central Portion of Simplot Area

Geology

The central portion of the Simplot Plant Area is located in a transition zone between the geology of the Bannock Range and the geology of the Michaud Flats. In this area the Michaud Gravel (Qm) is present as a deposit on top of the American Falls Lake Beds (Qam). The northern limit of the lake bed clay in the subsurface approximately correlates with the location of Highway 30 (Figure 3-9). Beneath the American Falls Lake Beds, the alluvial fan deposits that originate from the Bannock Range (Qfg) interfinger with the Sunbeam Formation (Qsu) and include lenses of loess (Ql) or colluvium mixed with loess (Qcb). The lithology of these formations is described in the preceding sections.

Hydrogeology

The central portion of the Simplot Plant Area is located where regional groundwater that is flowing downward due to recharge, along with seepage water from the Simplot gypsum stacks, begins to migrate upward toward discharge areas located along the Portneuf river. This upward movement of groundwater is not only evidenced by the large upward groundwater flow gradients present between the deep aquifer (referenced locally as the Lower Zone), comprised of the alluvial fan deposits (Qfg) and the Sunbeam Formation (Qsu), and the shallow aquifer (referenced locally as the Upper Zone), comprised of the Michaud Gravel (Qm), but also by the upward hydraulic gradients present within the Lower Zone. The saturated thickness of the Michaud Gravel (Qm) where it overlies the American Falls Lake Beds ranges from less than 10 feet to 25 feet in most areas, then increases in thickness towards the erosional limit of the American Falls Lake Beds to the north (Figure 3-11)

The hydrogeology of the central portion of the Simplot Area has been investigated in detail in previous investigations. Initially this area was investigated as part of the RI and was identified as the best location for placing the groundwater extraction system. Subsequent investigations were then conducted in association with the phased implementation of the test extraction system. Results of these investigations are included in the discussion of site-specific hydrogeology in Section 3.3.2.

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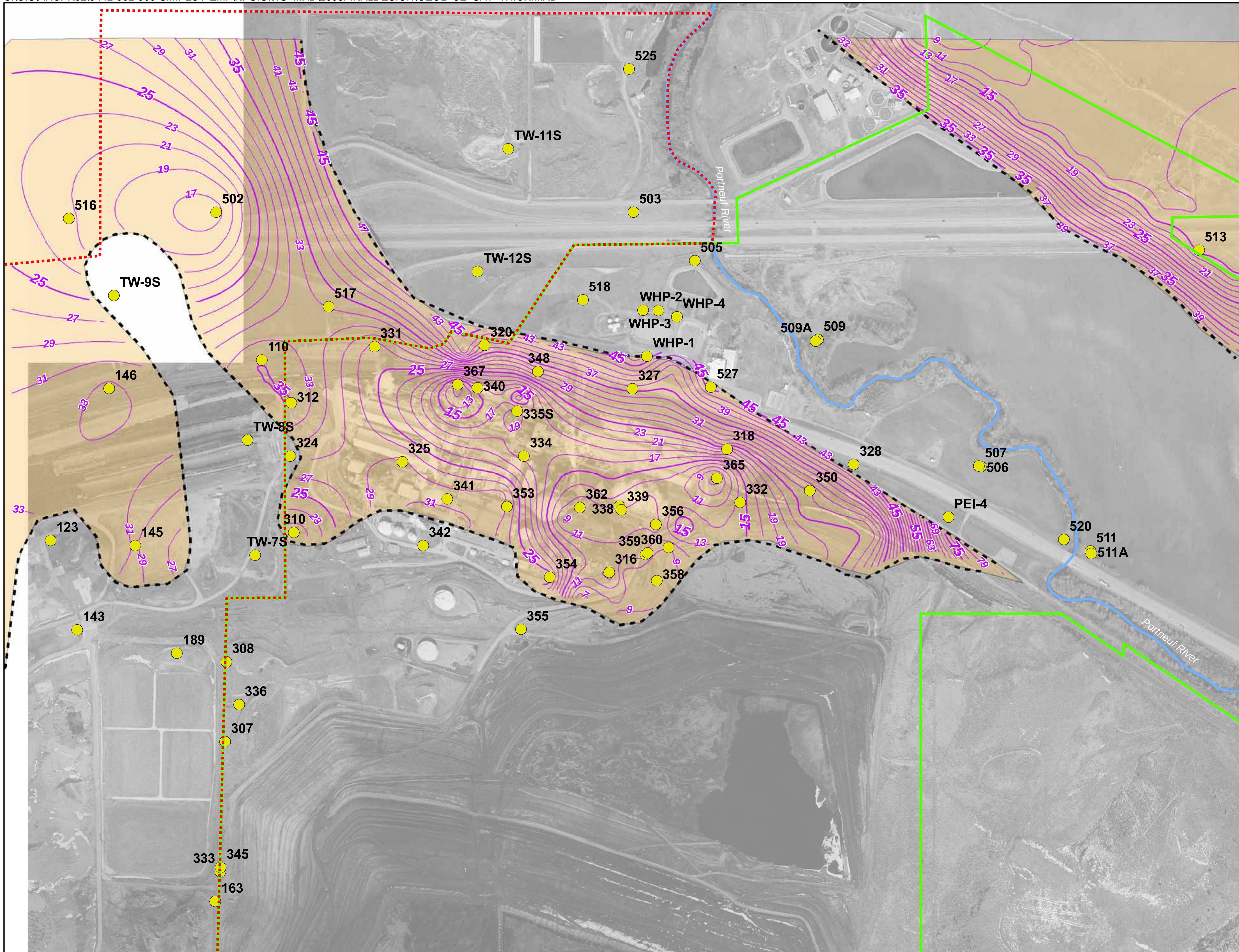


Legend

- FMC
- SIMPLOT
- Portneuf River
- Shallow Monitoring Wells
- Upper Zone Saturated Thickness (ft)
- AFLB Limit
- Estimated extent of AFLB

Aerial Photo: March 3, 2008

N

Feet

0 600 1,200

J.R. SIMPLOT

EASTERN MICHAUD FLATS

FIGURE 3-11

SATURATED THICKNESS OF THE MICHAUD GRAVEL (Qm) WHERE IT OVERLIES THE AMERICAN FALLS LAKE BED

PRJ: 0442-002-900	NOV 4, 2008
REV: 0	BY: MCP CHK: BC

FORMATION ENVIRONMENTAL

3.3.2 Site-Specific Hydrogeology

Investigations of the hydrogeology of the Simplot Plant Area were initially conducted during the RI, and have subsequently been conducted in association with the installation of the test extraction system and to fill data gaps necessary for the completion of the groundwater monitoring system. The purpose of this section is to describe in more detail the site-specific hydrogeologic details that are important for the design of the groundwater extraction and monitoring systems. A continuous line of east-west cross sections that correlate with the target capture zones (see Section 4.1) are provided for reference.

Based on hydrogeologic properties, geologic strata in the Simplot Area can be divided into four hydrostratigraphic units: the Tertiary volcanics (also referred to as bedrock), the Upper Zone which consists of the Michaud Gravel that overlies the American Falls Lake Bed clay (AFLB), the AFLB itself, which is a local confining unit, and the Lower Zone, which consists of the materials below the AFLB.

3.3.2.1 East Plant Area

East-west geologic cross sections showing stratigraphic detail in the Upper Zone are shown in Figures 3-12, 3-13, and 3-14. Similar cross sections for the Lower Zone are shown in Figures 3-15 and 3-16. The sections show lithologic and geologic interpretations of boring log data, well construction details for wells located near the section lines, and the results of aquifer testing completed at the wells.

In this area, the Upper Zone consists of a thin (approximately 10 ft) section of Michaud Gravel (Qm) overlying about 25 feet of AFLB silt and clayey silt. At the easternmost portion of the area, an eastward thickening section of clay-rich alluvial fan gravel (Qf) is also encountered.

The Lower Zone lithology varies considerably beneath the AFLB. At boring B-410, an exploration boring drilled next to well 410 (NewFields 2008a), most of the Lower Zone consists of alluvial fan gravel (clay-rich gravel composed mostly of coarse angular volcanic clasts; Qfg), and loess (Ql) overlying andesite bedrock of the upper member of the Starlight Formation (Tsup). At boring B-412B (the pilot boring for well 412), the unconsolidated sediments of the Lower Zone extend to a depth 55 feet deeper than at B-410 and consist of about 50 feet of clean quartzite sands and gravels of the Sunbeam Formation (Qsu) overlying the clayey gravel alluvial fan and loess deposits. The Lower Zone section thins by about 100 feet at boring B-412 only 165 feet southwest of well 412 (not shown on section). The Lower Zone section also thins to the east. Near well 413 the Lower Zone geology consists of mostly quartzite sands and gravels of the Sunbeam Formation (Qsu) overlying andesite bedrock of the upper member of the Starlight Formation (Tsup). At well 413, the Lower Zone also includes some thick beds of loess (up to 20 ft) and one bed of alluvial fan gravel. In the north-south direction, the Lower Zone transitions from alluvial fan gravels (Qfg) at well 363 to quartzite sands and gravels of the Sunbeam Formation (Qsu) at well 368.

3.3.2.2 Central Plant Area

A a series of east-west hydrogeologic cross sections in the Central Plant Area are shown in Figure 3-17. This section includes the wells installed during the subsurface investigation in the PAP area in early 2009 and wells 367, 340, and 414 which were installed in previous investigations. In this section, the Upper Zone consists of a thin section of Michaud Gravel (Qm). The saturated thickness varies from about 10 ft at wells 367 and 414 to about 30 ft at wells 419 and 420.

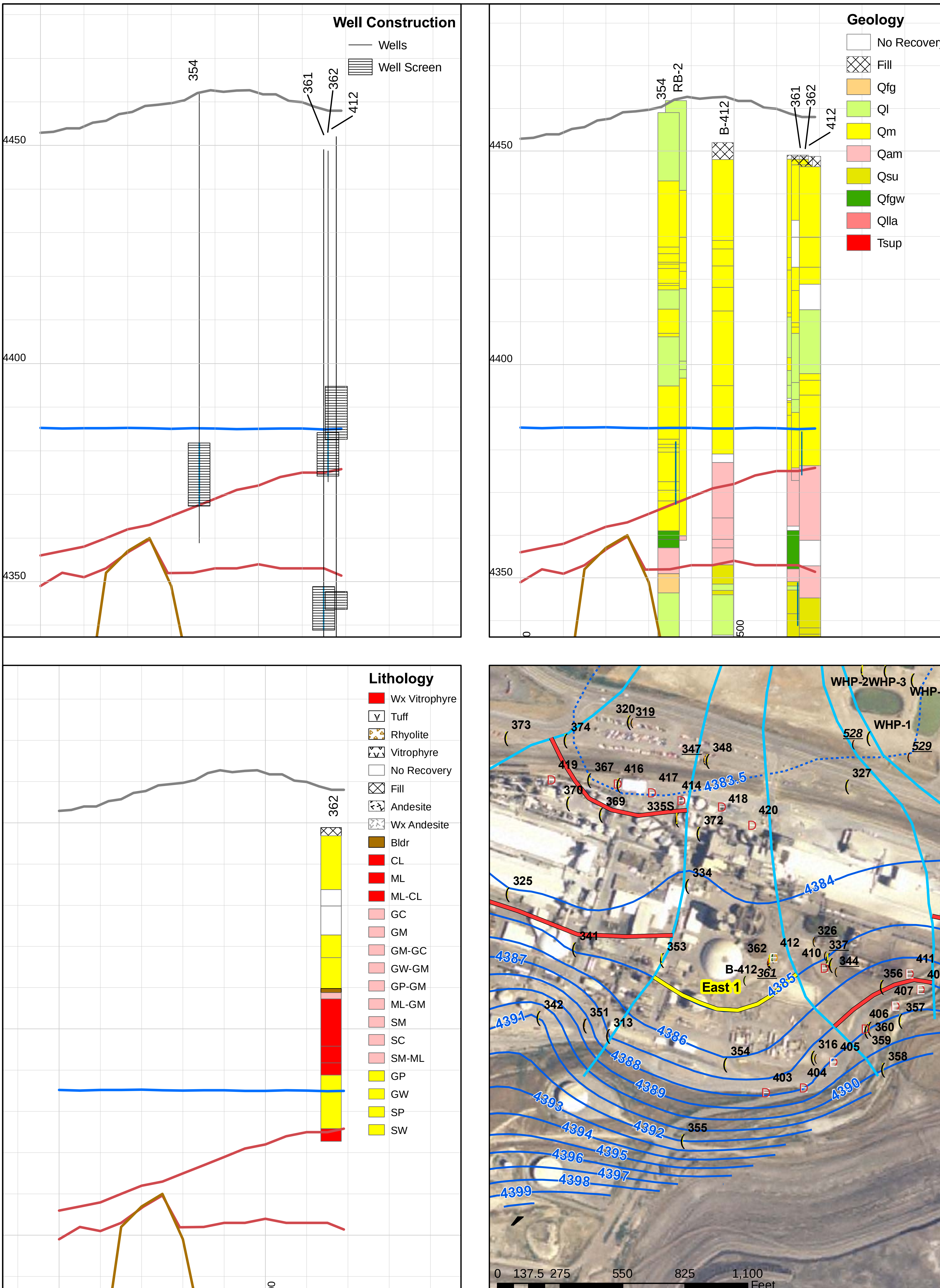
No aditional investigations of the Lower Zone in the central plant area have been conducted since the RI. An east-west cross section showing the geology of the Lower Zone is shown in Figure 3-18.

3.3.2.3 West Plant Area

East-west geologic cross sections including extraction well 415 and wells 309 and 310 are shown in Figures 3-19 and 3-20. At this location the AFLB is absent. The deposits consist of alluvial fan gravel deposits. Most of the gravel contains silt and clay and consists of angular volcanic clasts. Large volcanic boulders are present as well as a relatively thick layer of clay.

3.3.2.4 Area North of Highway 30, Well 528 and 529 Vicinity

An east-west geologic cross section including well 528, the boring for well 529, and the boring for well 526 is shown in Figure 3-21. This section is located near the northern limit of the AFLB, near where the AFLB was eroded by ancient flooding and replaced by Michaud Gravel. The Upper Zone is about 40 to 45 feet thick and consists of Michaud Gravel (Qm). The Lower Zone consists of quartzite sands and gravels of the Sunbeam Formation (Qsu).



Legend

- Ground Surface
- UZ GW Elevation 8/03
- Top AFLB
- Bottom AFLB
- Top Starlight Formation
- Multi-Level Monitoring Wells (underlined italic)
- Deep Monitoring Wells (underlined)
- Upper Zone Cross Section Line
- Upper Zone Cross Section Line Shown In Plan View
- Potentiometric Surface Upper Zone
- Multi-Level Extraction Wells
- Extraction Wells
- Shallow Monitoring Wells
- Bedrock Wells
- Pilot Borings
- Exploration Borings

Cross-sections include 10x vertical exaggeration.

J.R. SIMPLOT
EASTERN MICHAUD FLATS

FIGURE 3-12

EAST AREA UPPER ZONE CROSS SECTION 1

PJT: #0442-002-900	JUL 8, 2009
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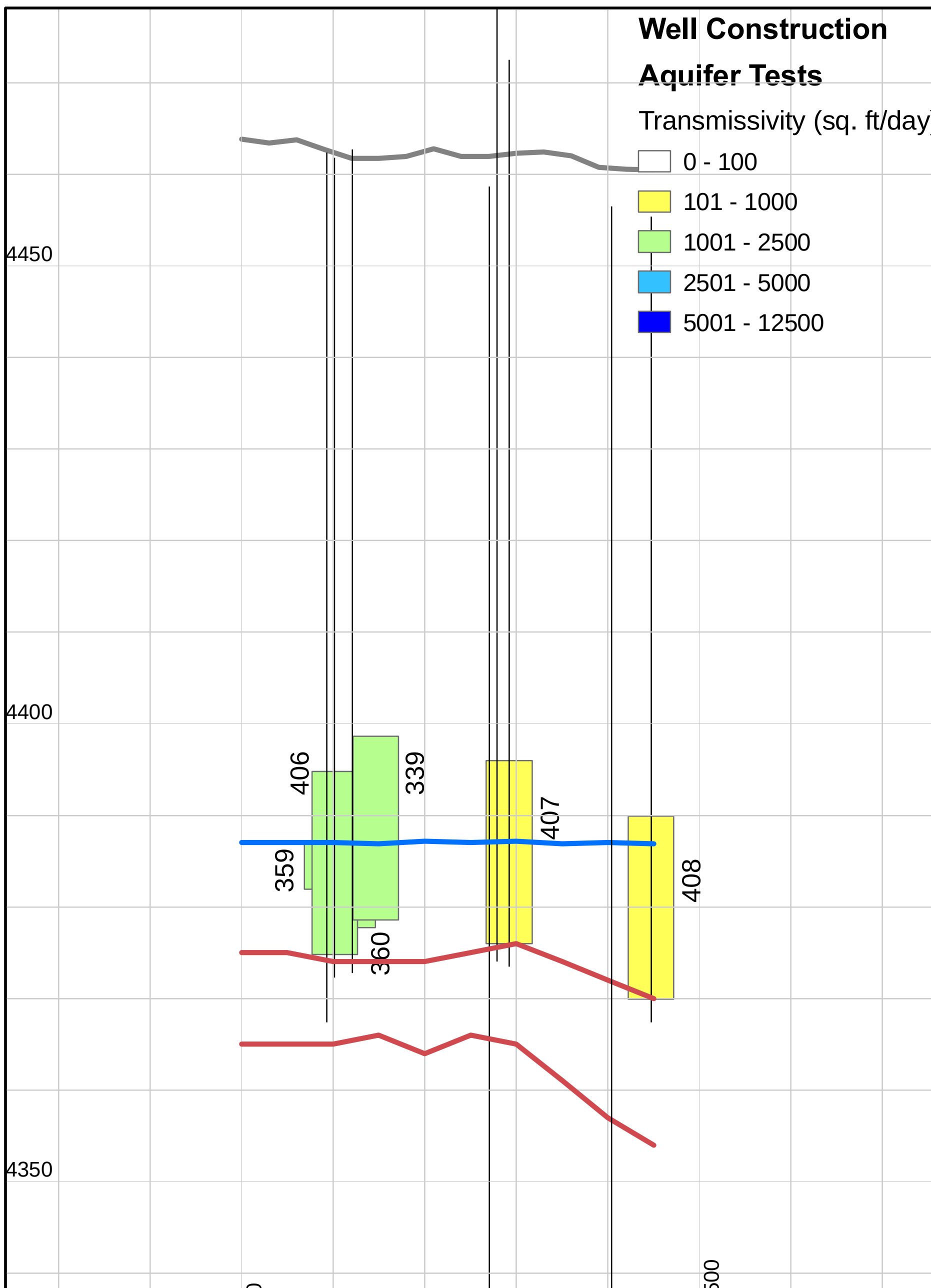
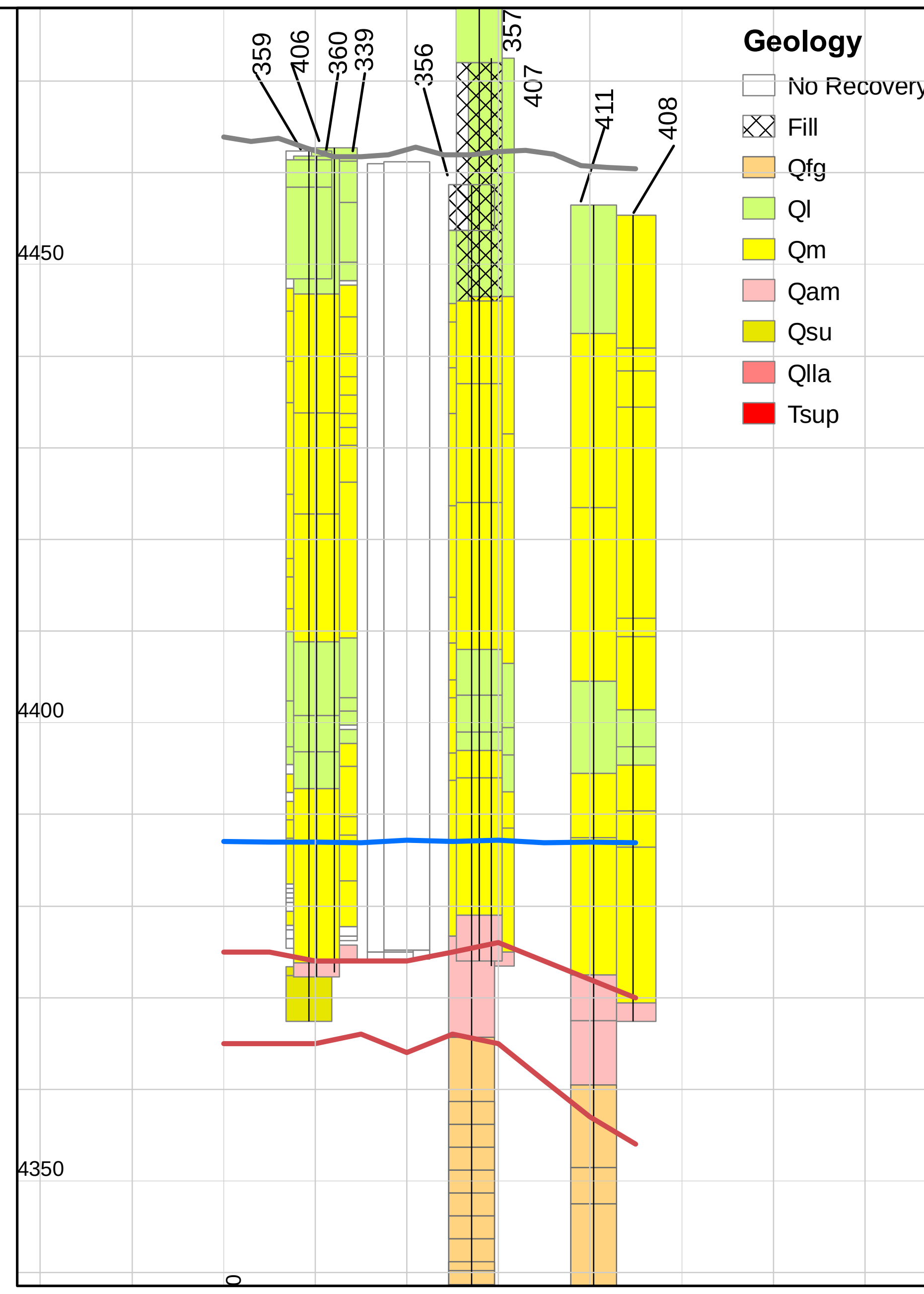
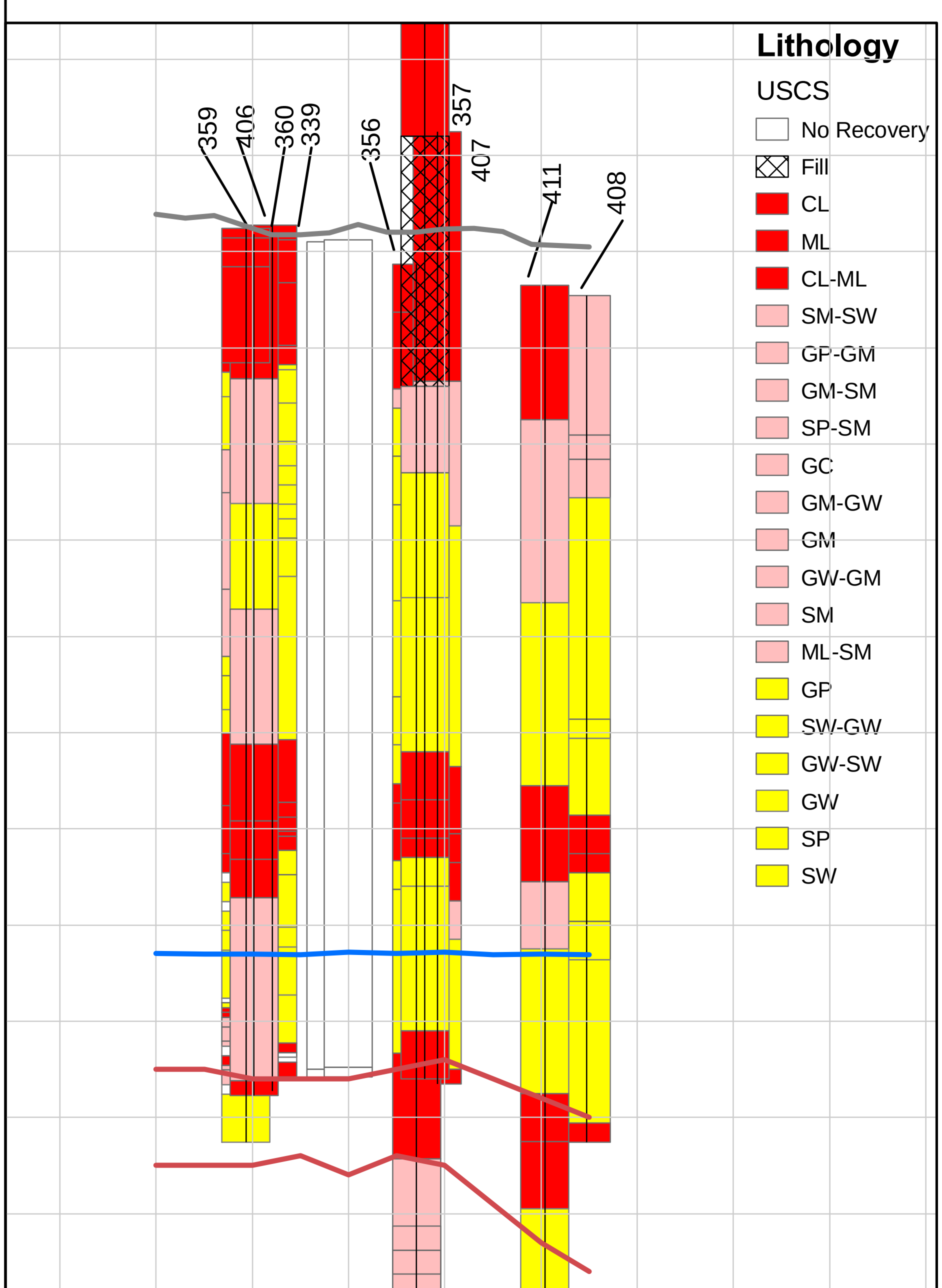
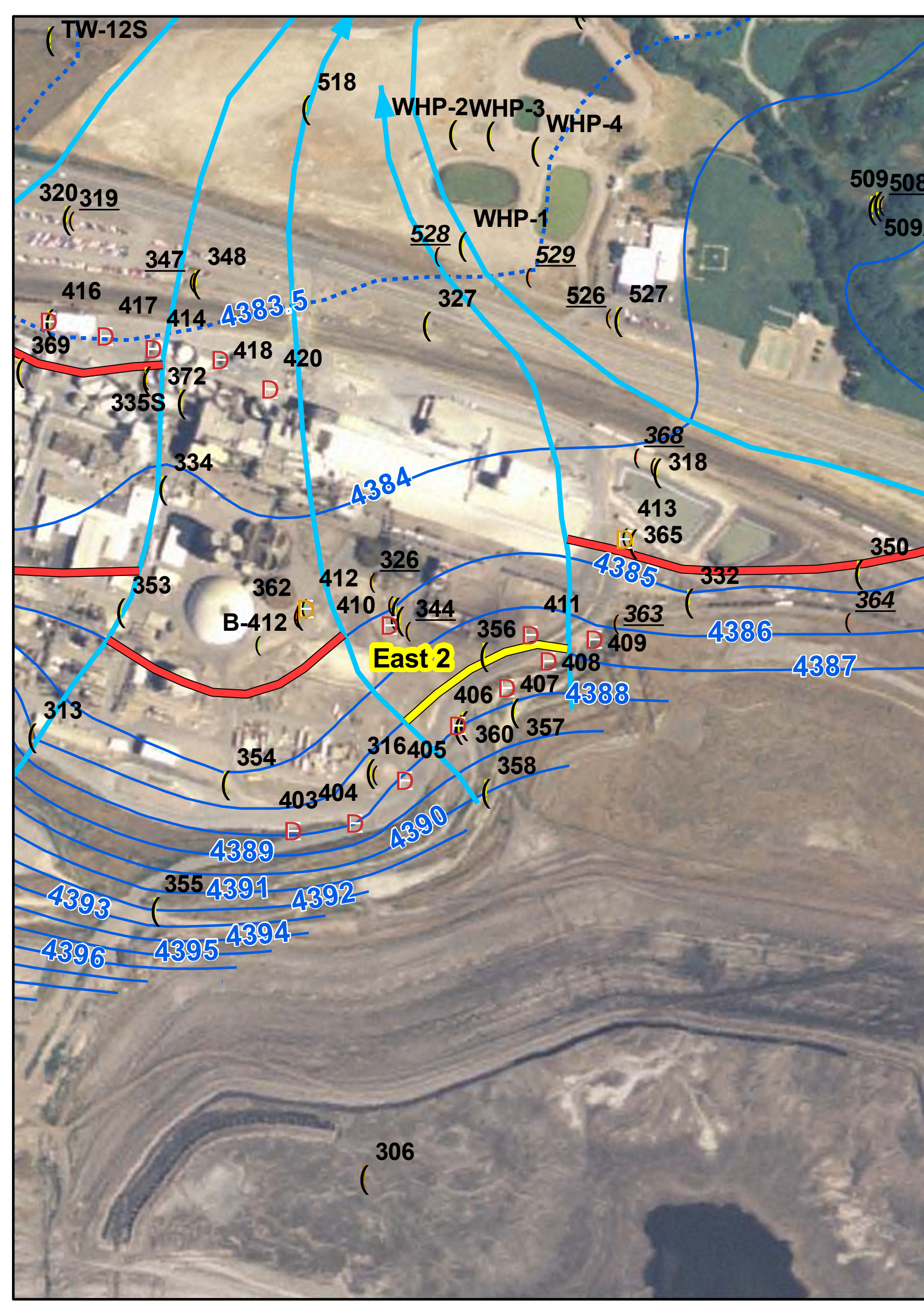
FORMATION ENVIRONMENTAL









Legend

- Ground Surface
- UZ GW Elevation 8/03
- Top AFLB
- Bottom AFLB
- Top Starlight Formation
- Multi-Level Monitoring Wells (underlined italic)
- Deep Monitoring Wells (underlined)
- Upper Zone Cross Section Line
- Upper Zone Cross Section Line Shown In Plan View
- Potentiometric Surface Upper Zone
- D Multi-Level Extraction Wells
- D Extraction Wells
- Shallow Monitoring Wells
- Bedrock Wells
- Pilot Borings
- Exploration Borings

J.R. SIMPLOT
EASTERN MICHAUD FLATS

FIGURE 3-13

EAST AREA UPPER ZONE CROSS SECTION 2

PJT: #0442-002-900	Jul 09, 2009
REV: 0	BY: TRA / CHECKED: BC

FORMATION ENVIRONMENTAL

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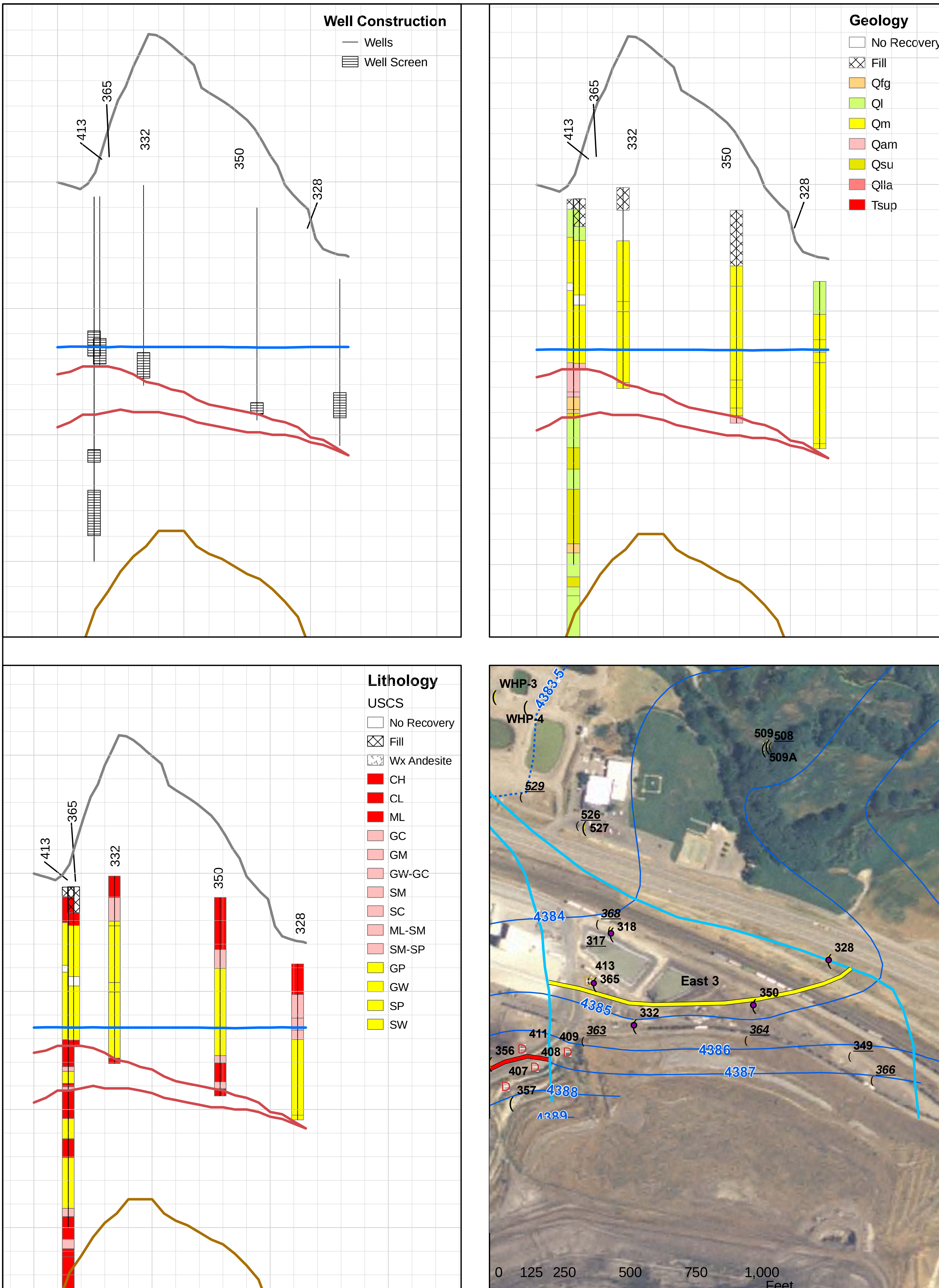

Legend

Ground Surface	Multi-Level Monitoring Wells (underlined italic)	Multi-Level Extraction Wells
UZ GW Elevation 8/03	Deep Monitoring Wells (underlined)	Extraction Wells
Top AFLB	Upper Zone Cross Section Line	Shallow Monitoring Wells
Bottom AFLB	Upper Zone Cross Section Line Shown In Plan View	Bedrock Wells
Top Starlight Formation	Potentiometric Surface Upper Zone	Pilot Borings
		Exploration Borings

Cross-sections include 10x vertical exaggeration.

J.R. SIMPLOT
EASTERN MICHAUD FLATS

FIGURE 3-14

EAST AREA UPPER ZONE CROSS SECTION 3

PJT: #0442-002-900	Jul 09, 2009	
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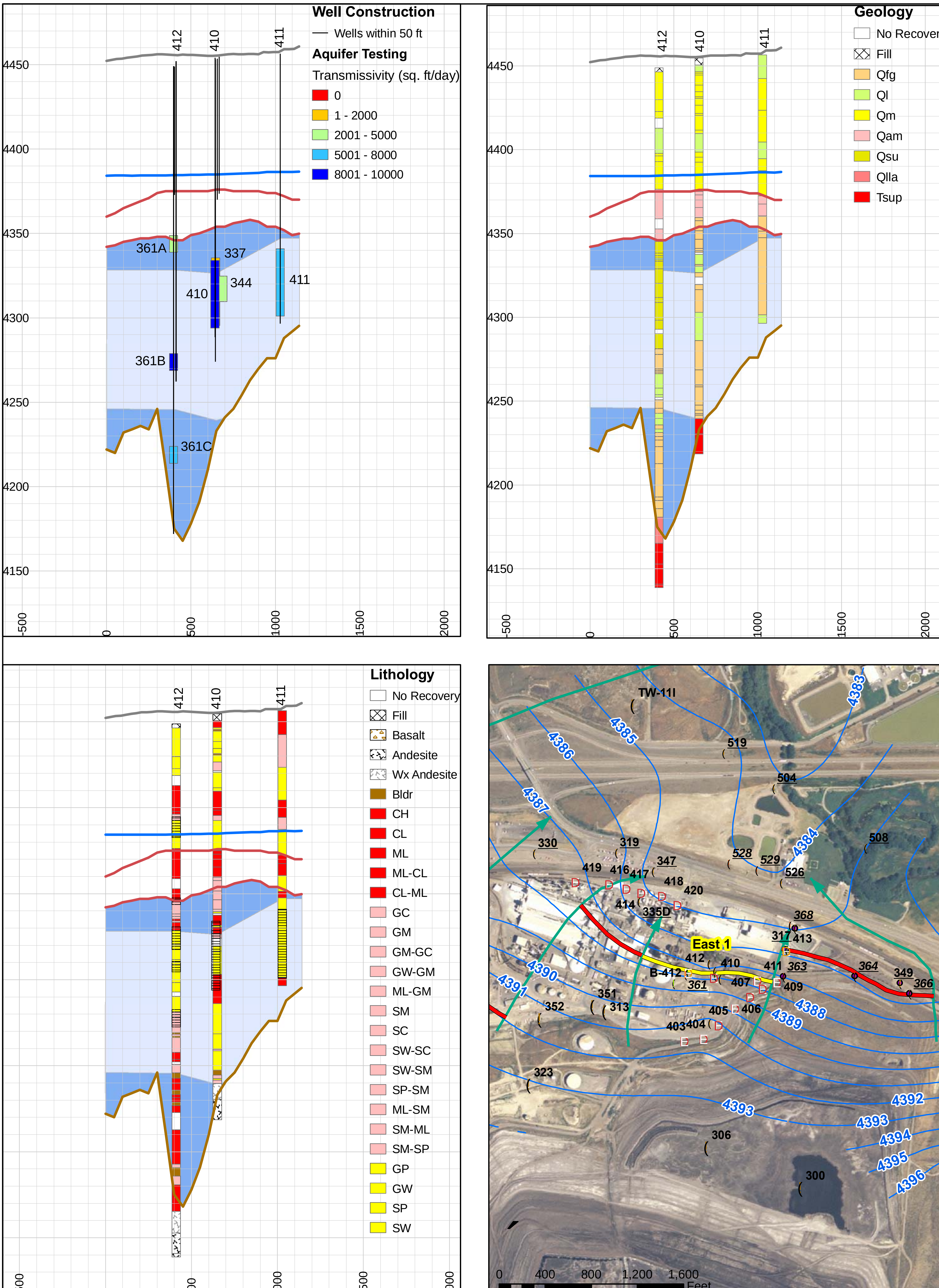
FORMATION ENVIRONMENTAL



Legend

Ground Surface	Multi-Level Monitoring Wells (underlined italic)	Multi-Level Extraction Wells
UZ GW Elevation 8/03	Deep Monitoring Wells (underlined)	Extraction Wells
Bottom AFLB	Lower Zone Cross Section Line	Bedrock Wells
Top AFLB	Lower Zone Cross Section Line Shown In Plan View	Pilot Borings
Top Starlight Formation	Potentiometric Surface Lower Zone	Exploration Borings

Transmissivity Zones

- Low
- High

Cross-section includes 10x vertical exaggeration.

J.R. SIMPLOT
EASTERN MICHAUD FLATS

FIGURE 3-15

EAST AREA LOWER ZONE CROSS SECTION 1

PJT: #0442-002-900	Jul 09, 2009
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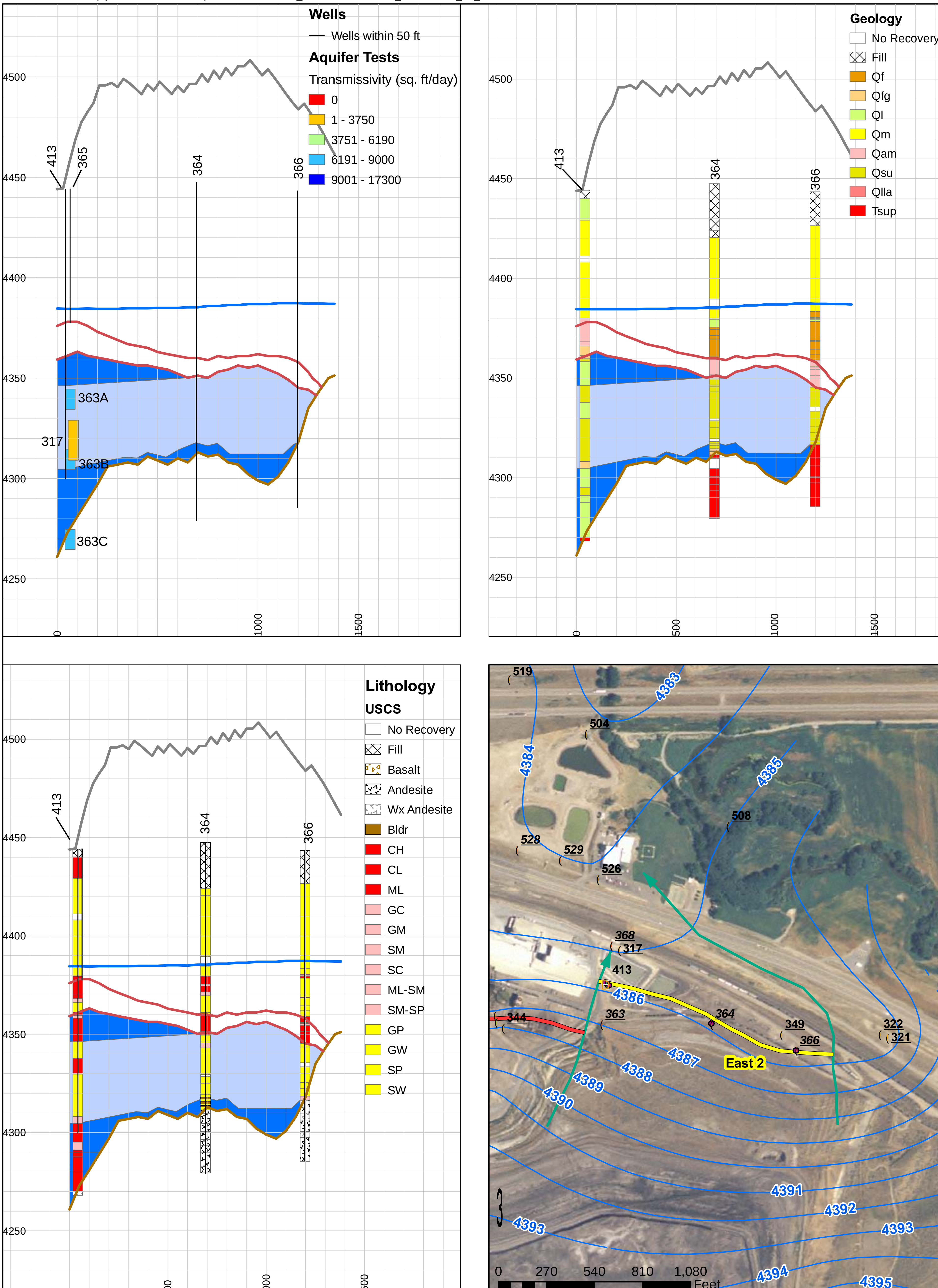
FORMATION ENVIRONMENTAL



Legend

Ground Surface	Multi-Level Monitoring Wells (underlined italic)	Multi-Level Extraction Wells
UZ GW Elevation 8/03	Deep Monitoring Wells (underlined)	Bedrock Wells
Top AFLB	Lower Zone Cross Section Line	Pilot Borings
Bottom AFLB	Lower Zone Cross Section Line In Plan View	Exploration Borings
Top Starlight Formation	Potentiometric Surface Lower Zone	

Transmissivity Zones

- Low
- High

Cross-section includes 10x vertical exaggeration.

J.R. SIMPLOT
EASTERN MICHAUD FLATS

FIGURE 3-16

EAST AREA LOWER ZONE CROSS SECTION 2

PJT: #0442-002-900	Jul 09, 2009
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FORMATION ENVIRONMENTAL

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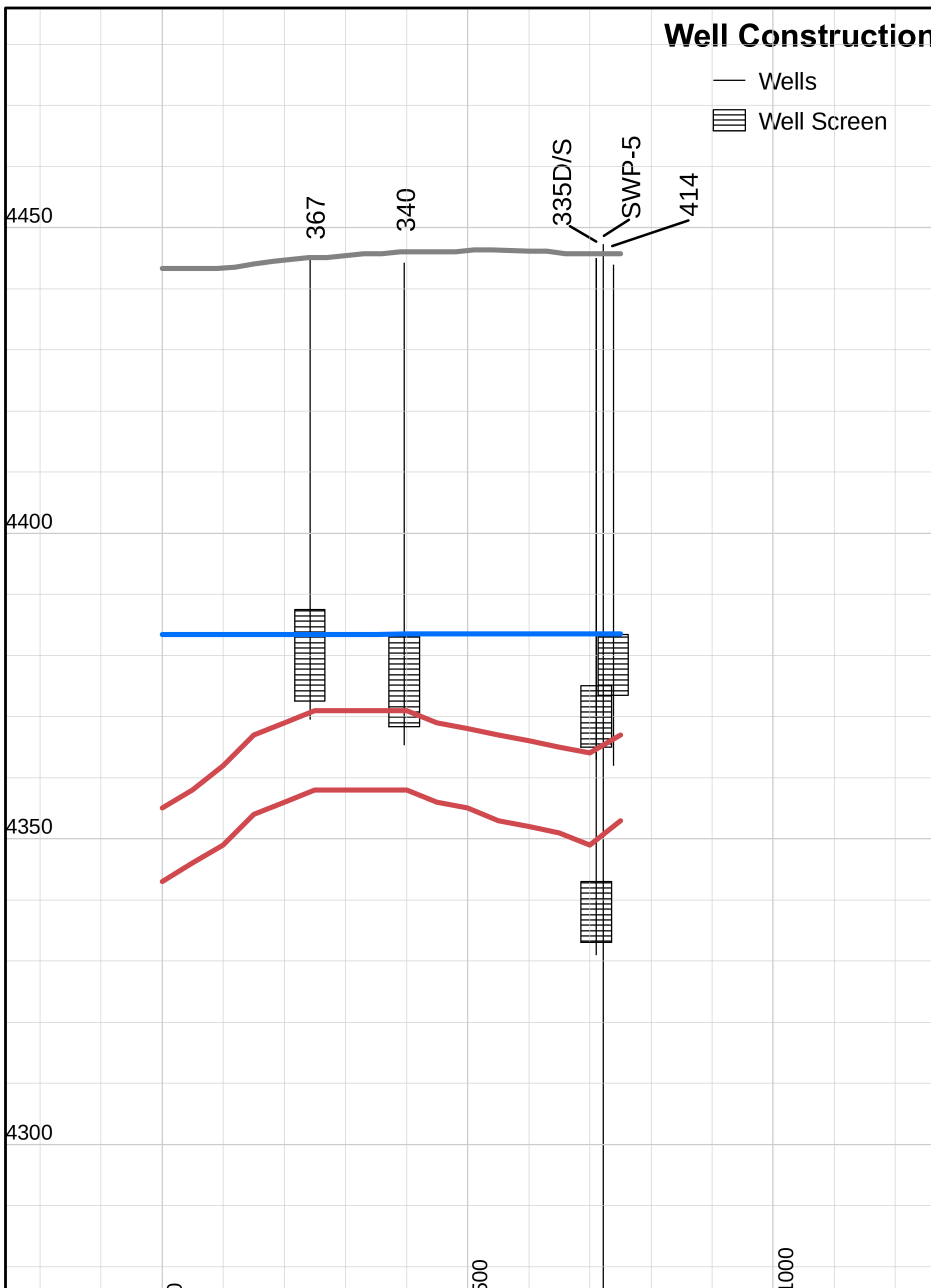

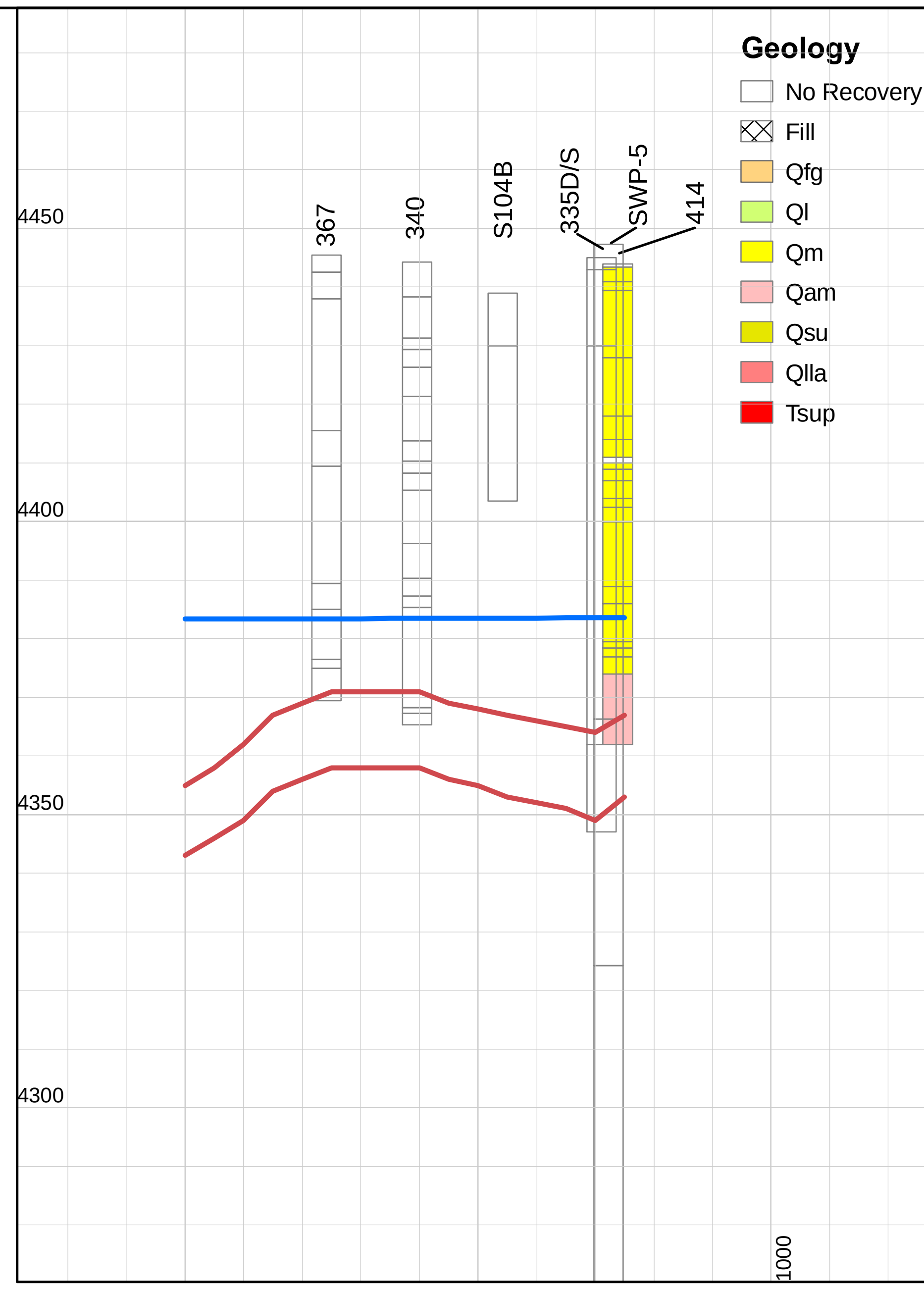

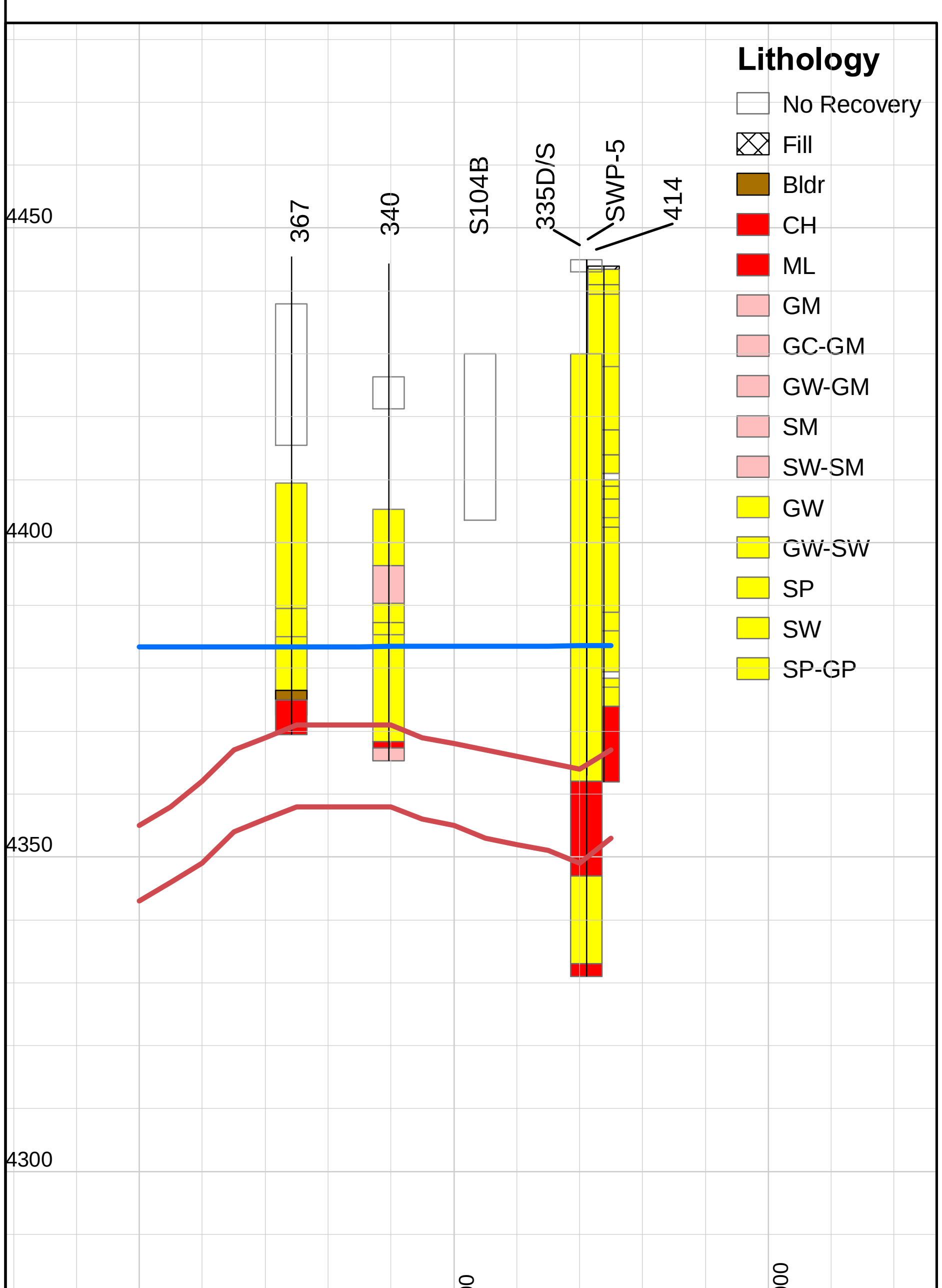

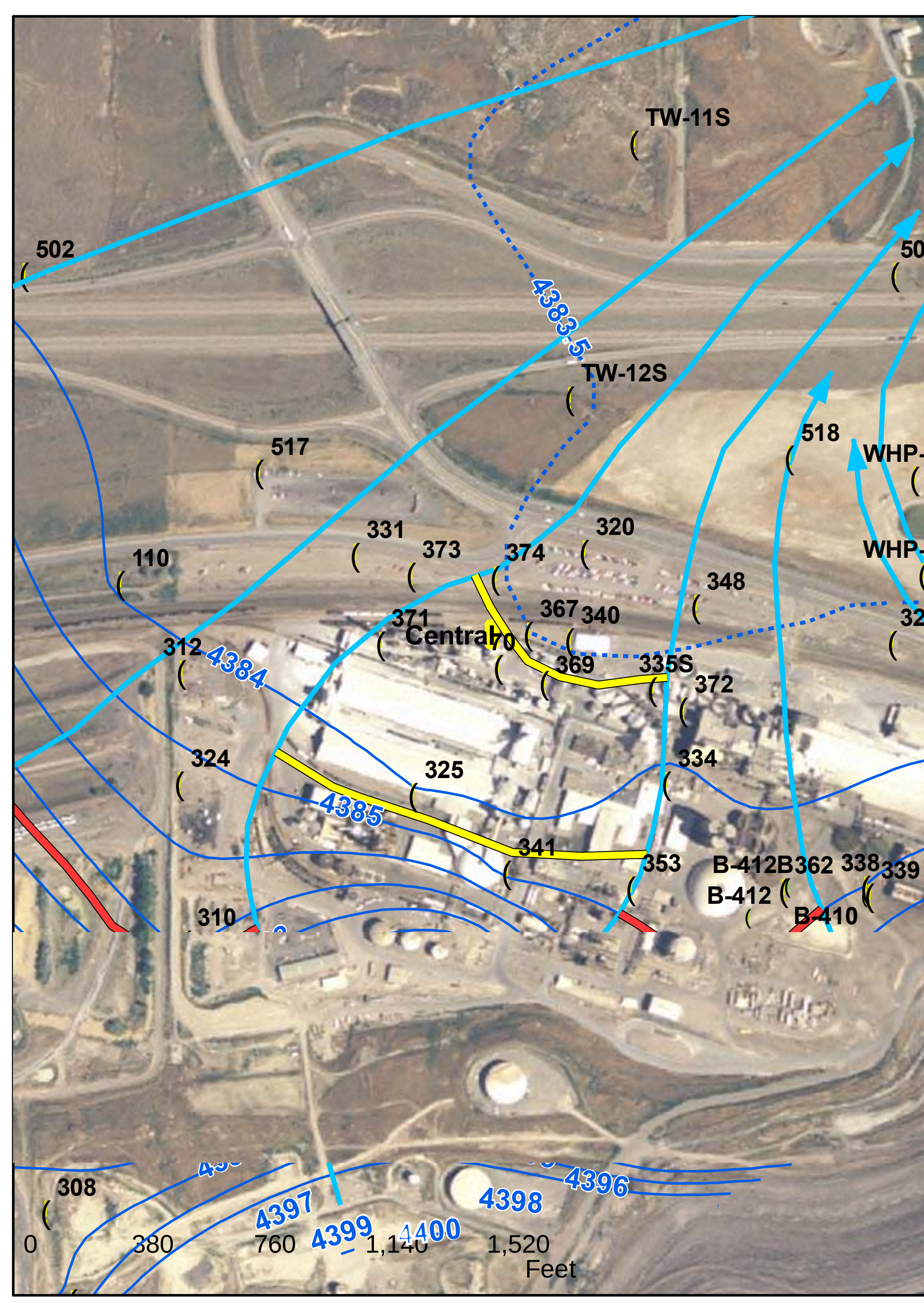

Legend

Ground Surface
UZ GW Elevation 8/03
Top AFLB
Bottom AFLB

Upper Zone Cross Section Line
Upper Zone Cross Section Line ShownIn Plan View
Potentiometric Surface Upper Zone

Shallow Monitoring Wells
Pilot Borings
Exploration Borings

Cross-sections include 10x vertical exaggeration.

J.R. SIMPLOT
EASTERN MICHAUD FLATS

FIGURE 3-17

CENTRAL AREA UPPER ZONE CROSS SECTION

PJT: #0442-002-900	Jul 09, 2009
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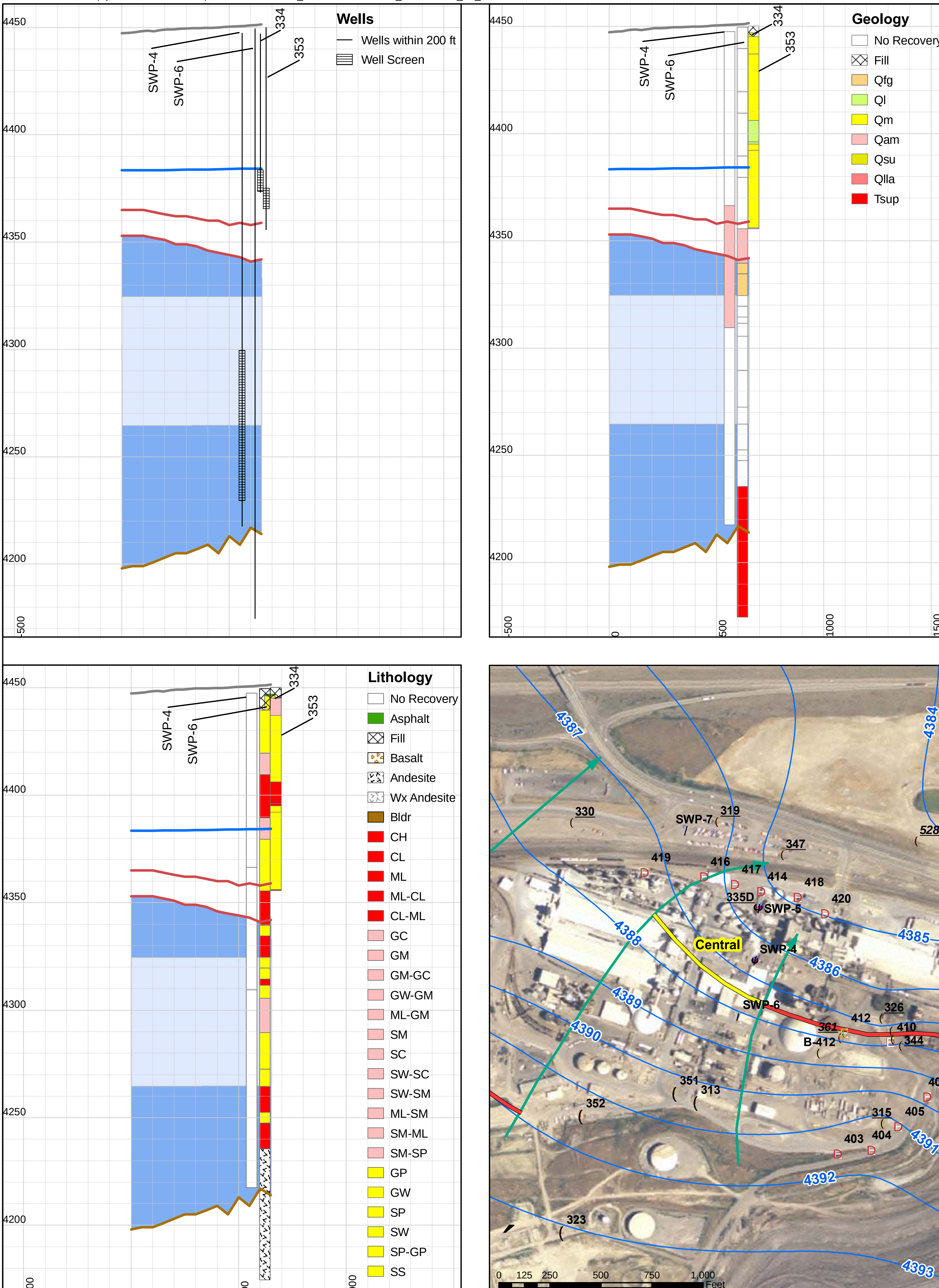
FORMATION ENVIRONMENTAL



Legend

Ground Surface
UZ GW Elevation 8/03
Top AFLB
Bottom AFLB
Top Starlight Formation

Transmissivity Zones

Low
High

Multi-Level Monitoring Wells (underlined italic)
Deep Monitoring Wells (underlined)
Lower Zone Cross Section Line
Lower Zone Cross Section Line Shown In Plan View
Potentiometric Surface Lower Zone

Multi-Level Extraction Wells
Extraction Wells
Supply Wells
Bedrock Wells
Pilot Borings
Exploration Borings

Cross-section includes 10x vertical exaggeration.

J.R. SIMPLOT
EASTERN MICHAUD FLATS

FIGURE 3-18

CENTRAL AREA LOWER ZONE CROSS SECTION

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FORMATION ENVIRONMENTAL

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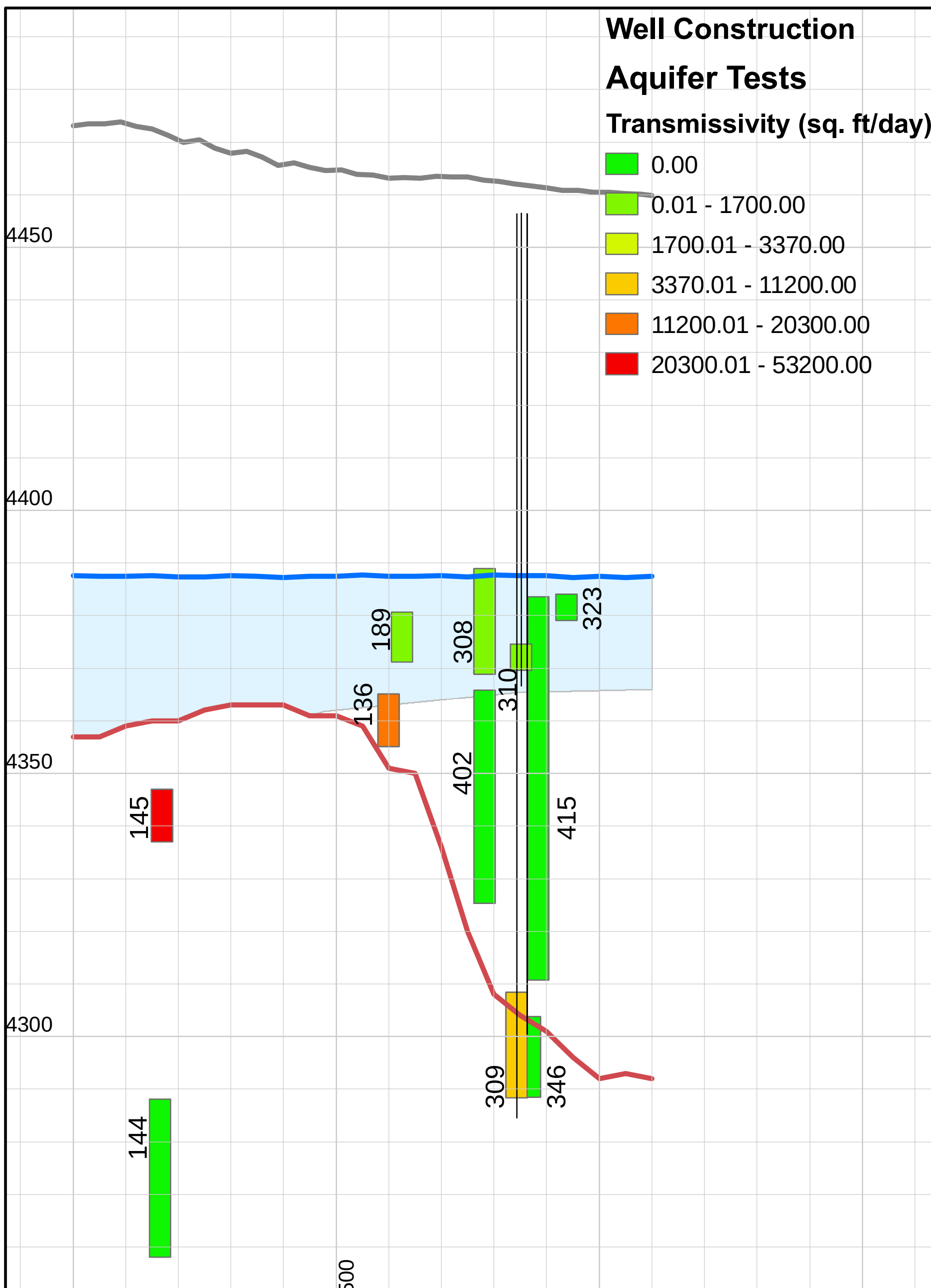

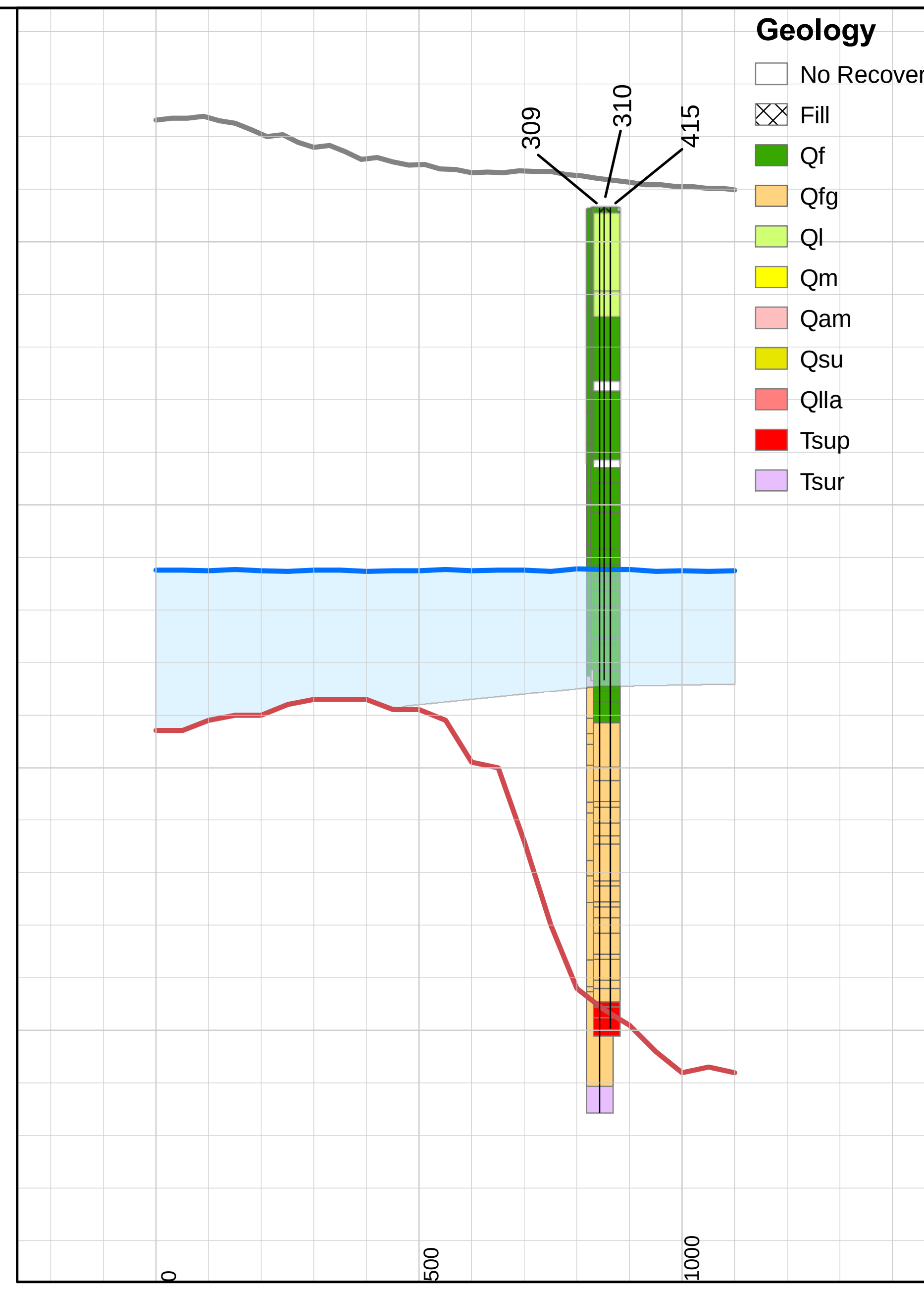

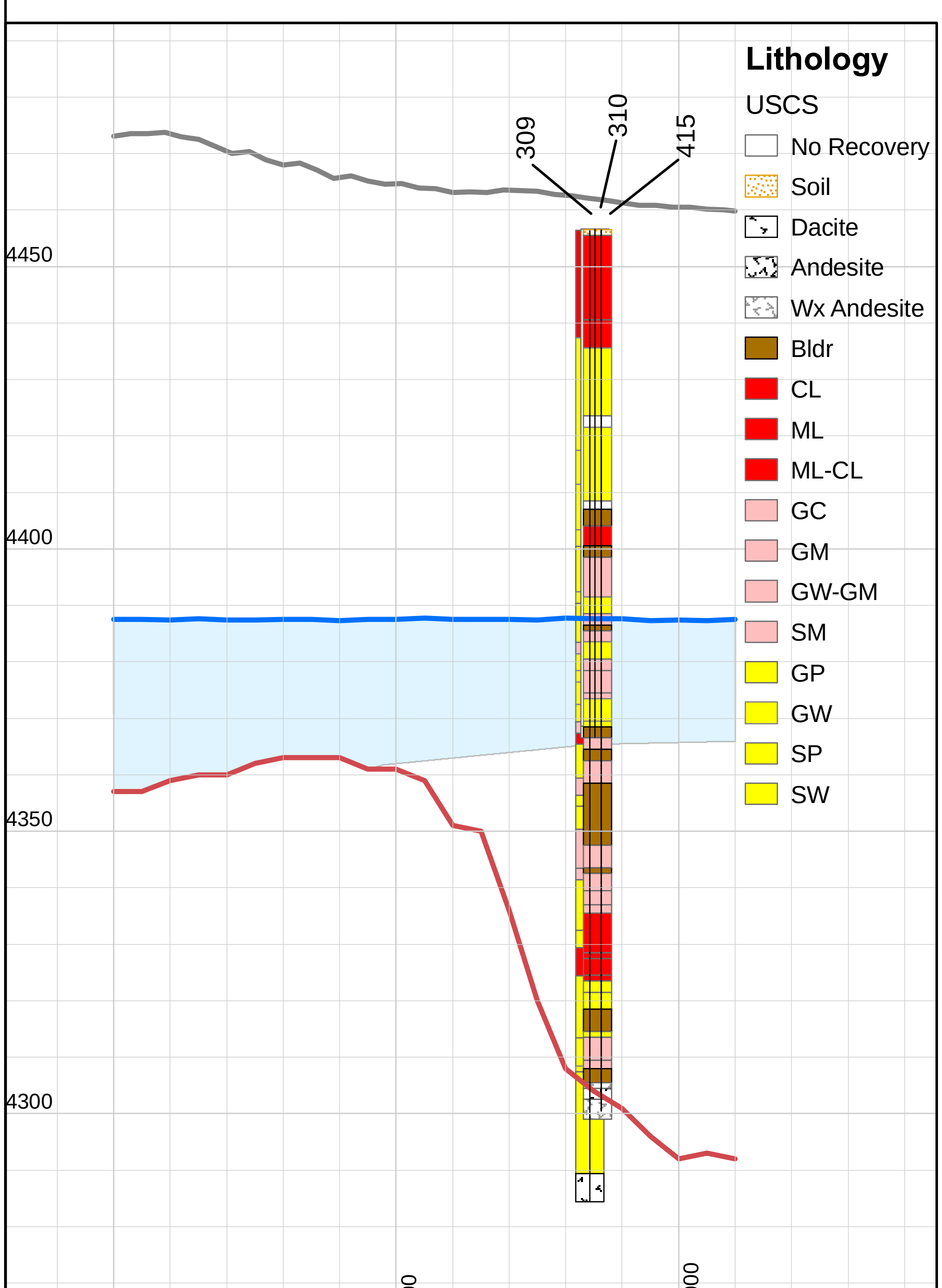

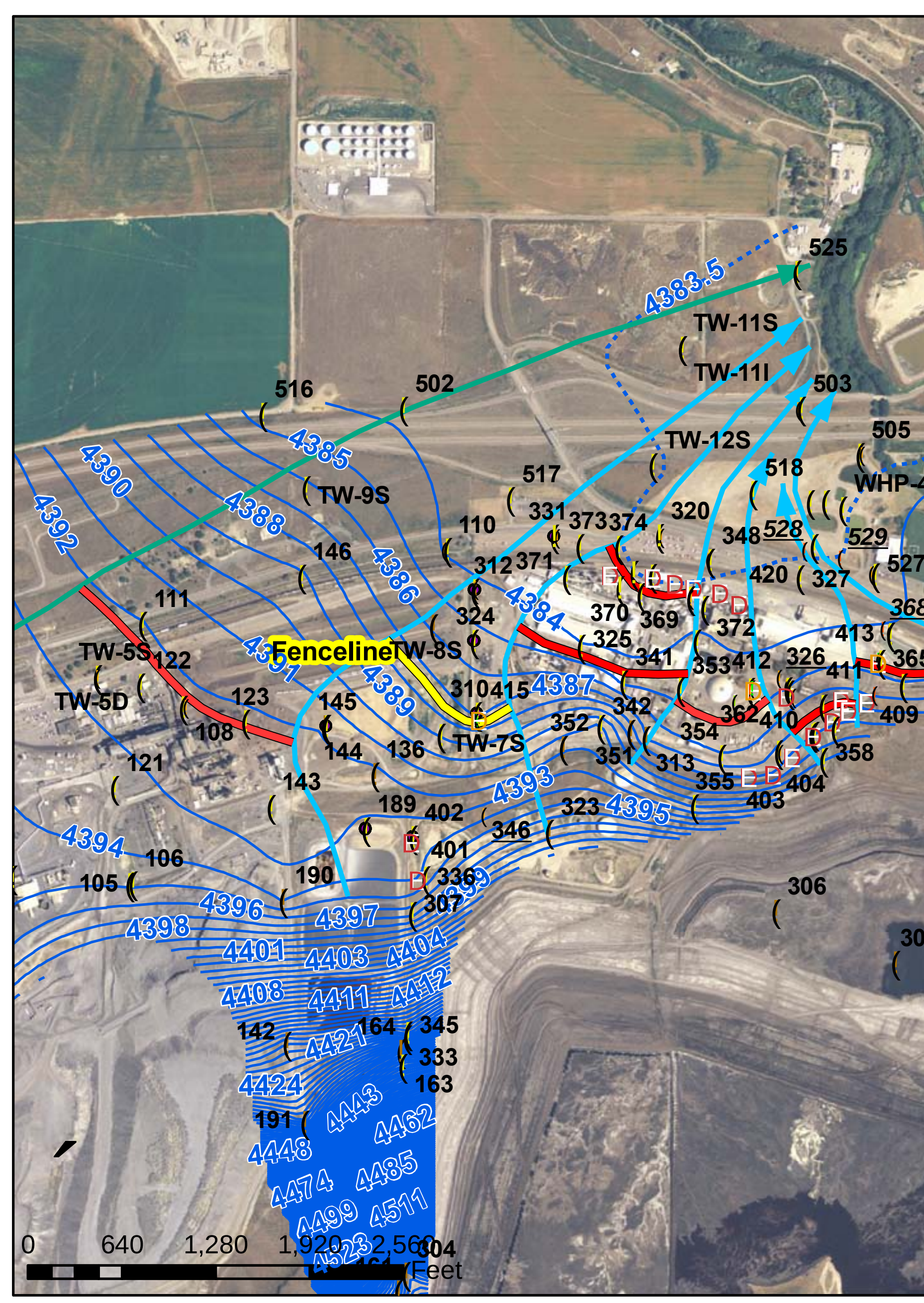

Legend

Ground Surface	Multi-Level Monitoring Wells (underlined italic)	Multi-Level Extraction Wells
UZ GW Elevation 8/03	Deep Monitoring Wells (underlined)	Extraction Wells
Top AFLB	Upper Zone Cross Section Line	Shallow Monitoring Wells
Upper Flow Zone	Upper Zone Cross Section Line Shown In Plan View	Bedrock Wells
	Potentiometric Surface Upper Zone	Pilot Borings
		Exploration Borings

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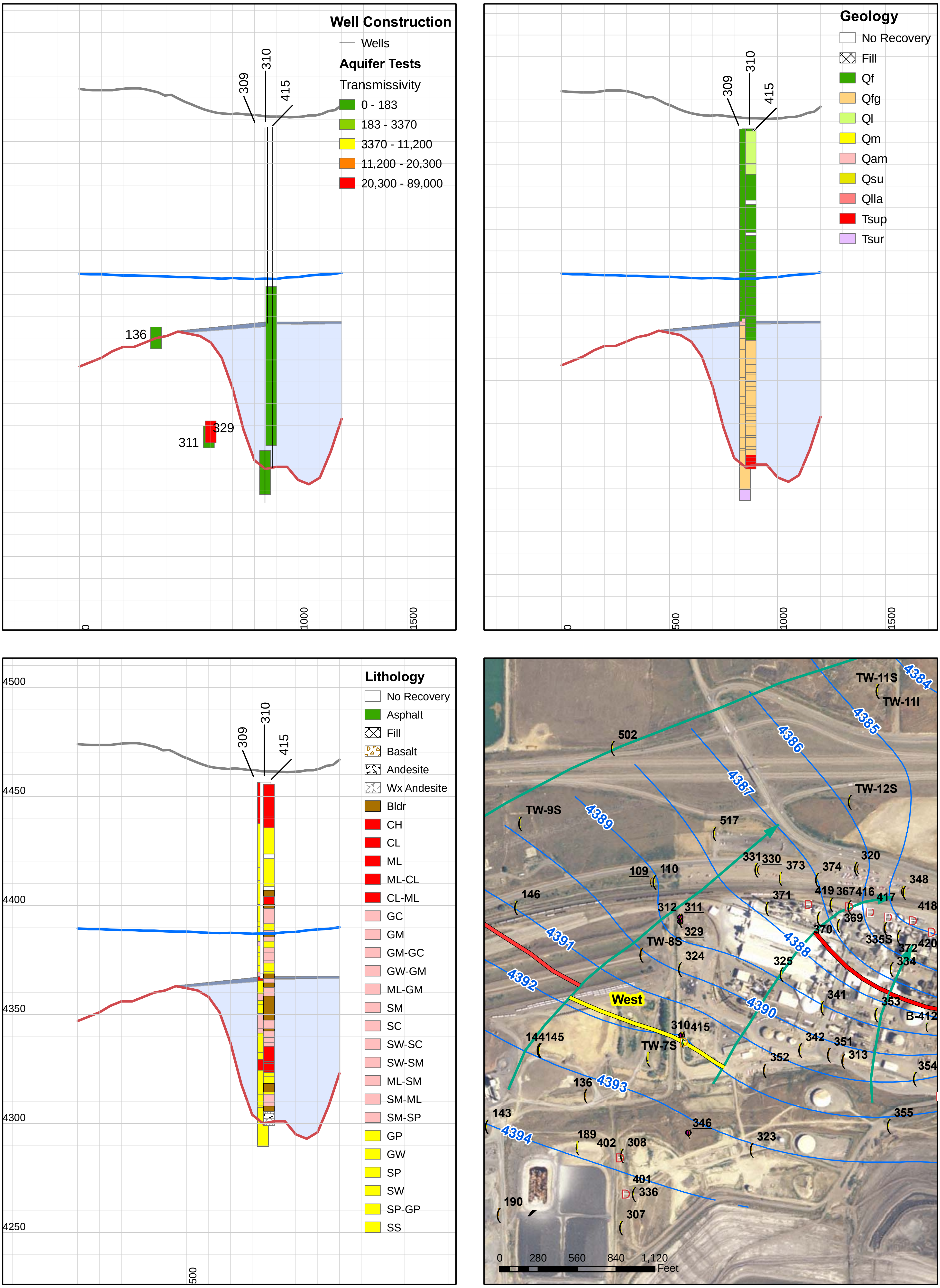
FIGURE 3-19

WEST AREA UPPER ZONE CROSS SECTION

PJT: #0442-002-900	Jul 09, 2009
REV: 0	BY: TRA CHECKED: BC

FORMATION ENVIRONMENTAL



Legend

Ground Elevation

UZ GW Elevation 8/03

Top of bedrock

Transmissivity Zones

Low

High

Multi-Level Monitoring Wells (underlined italic)

Deep Monitoring Wells (underlined)

Lower Zone Cross Section Line

Lower Zone Cross Section Line Shown In Plan View

Potentiometric Surface Lower Zone

Multi-Level Extraction Wells

Extraction Wells

Shallow Monitoring Wells

Bedrock Wells

Pilot Borings

Exploration Borings

Cross-sections include 10x vertical exaggeration.

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FIGURE 3-20

WEST AREA LOWER ZONE CROSS SECTION

PJT: #0442-002-900	Jul 09, 2009	
REV: 0	BY: TRA	CHECKED: BC

FORMATION ENVIRONMENTAL

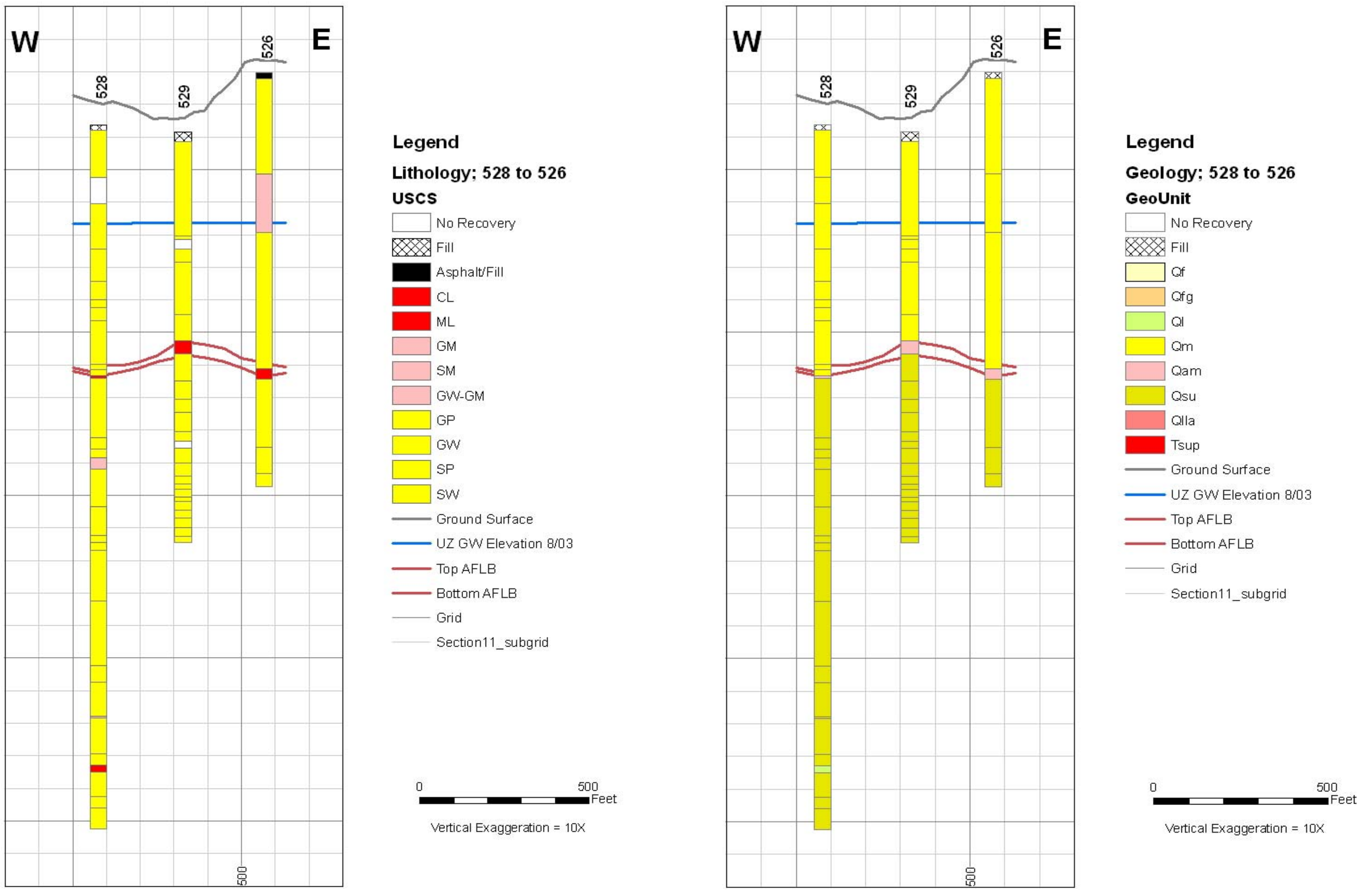

Figure 3-21: East-West cross section from well 526 to well 528.

3.3.2.5 Groundwater Hydraulic Gradient

Groundwater levels were measured in all available monitoring wells in the FMC and Simplot Plant Areas in August 2003, prior to the installation of the test extraction system. Potentiometric maps for the Simplot Area are shown in Figures 3-22 and 3-23. The Upper Zone potentiometric surface map includes all data indicating water table location, including wells completed in the Starlight Formation in the Bannock Range. The Lower Zone potentiometric surface map includes wells completed below the American Falls Lake Bed confining unit (AFLB). This potentiometric surface map is the best available representation of pre-extraction system hydraulic conditions.

Hydraulic gradients in the Upper Zone decrease from the southern limit of the zone to the north. This trend correlates with an increase in hydraulic conductivity. Groundwater flow paths (lines perpendicular to groundwater flow) converge at the Portneuf River in a narrow reach where the Batiste Springs are located (labeled as springs on Figure 3-22).

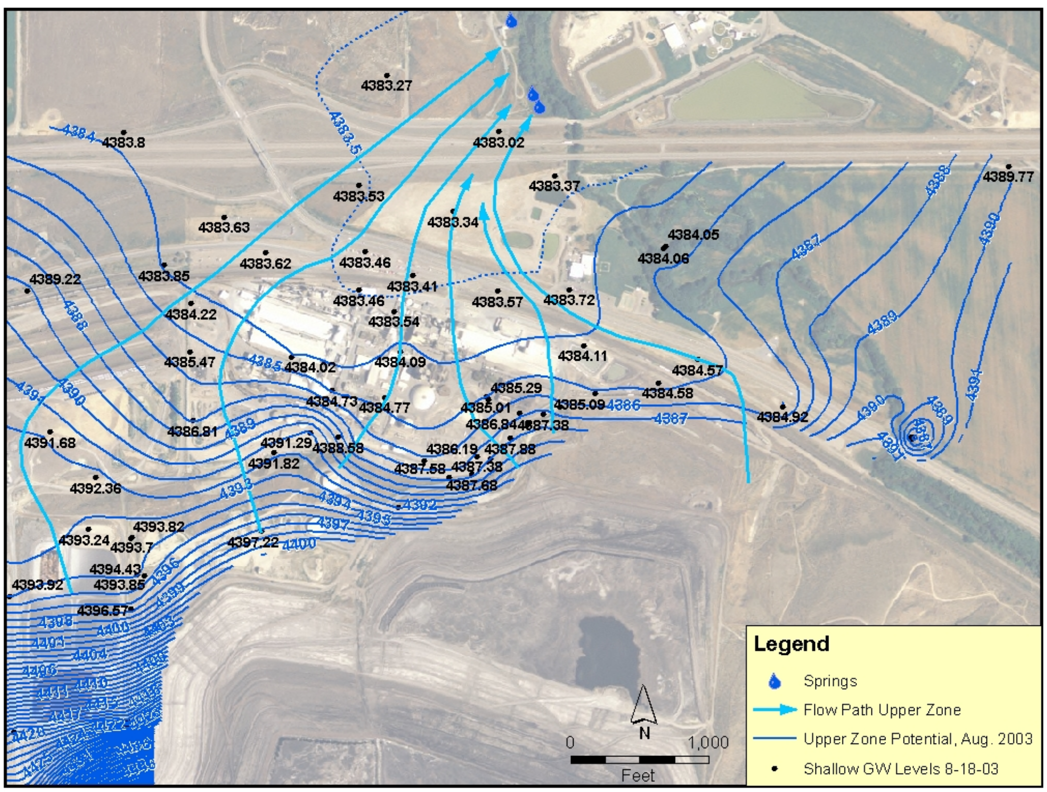

Figure 3-22: Interpreted potentiometric surface for the Upper Zone, August 2003.

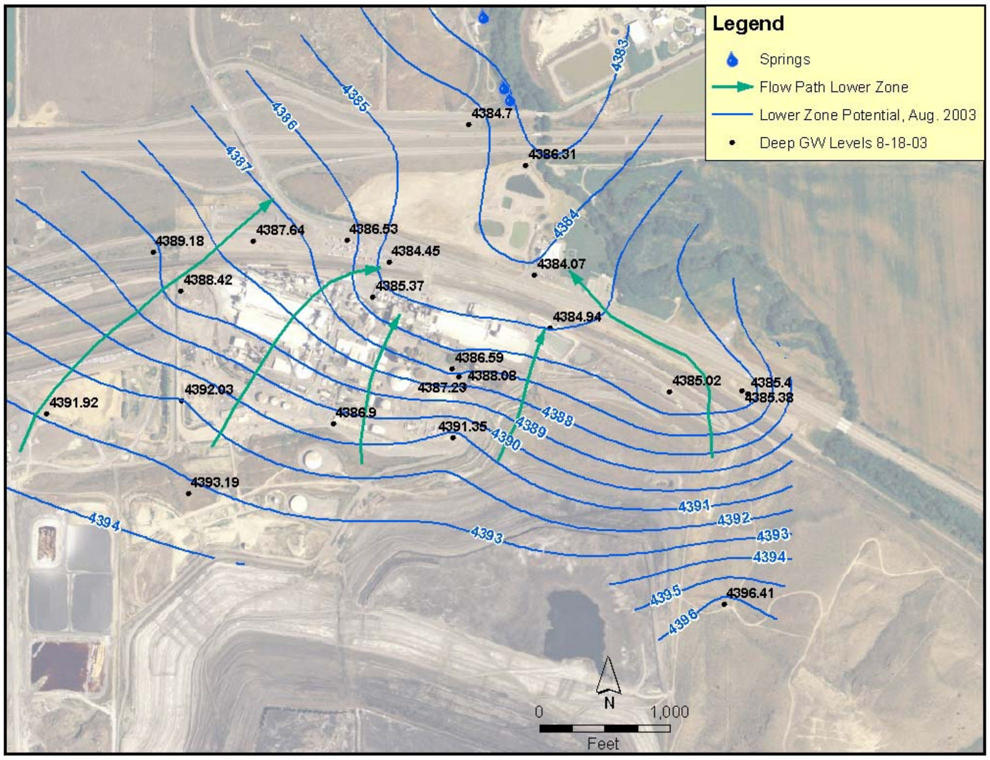

Figure 3-23: Interpreted potentiometric surface for the Lower Zone, August 2003.

Hydraulic gradients in the Lower Zone follow a pattern similar to those in the Upper Zone south of the location of Highway 30. At the location of Highway 30, the AFLB clay pinches out and the Upper and Lower Zones merge. There is a large upward hydraulic gradient within the Lower Zone at this location. Measurements of water levels at nested wells indicate that the upward hydraulic groundwater gradient in this area is from 10 to 100 times greater than the horizontal flow gradient (Figure 3-24). The groundwater flow paths shown in Figure 3-23 only represent lateral groundwater flow directions.

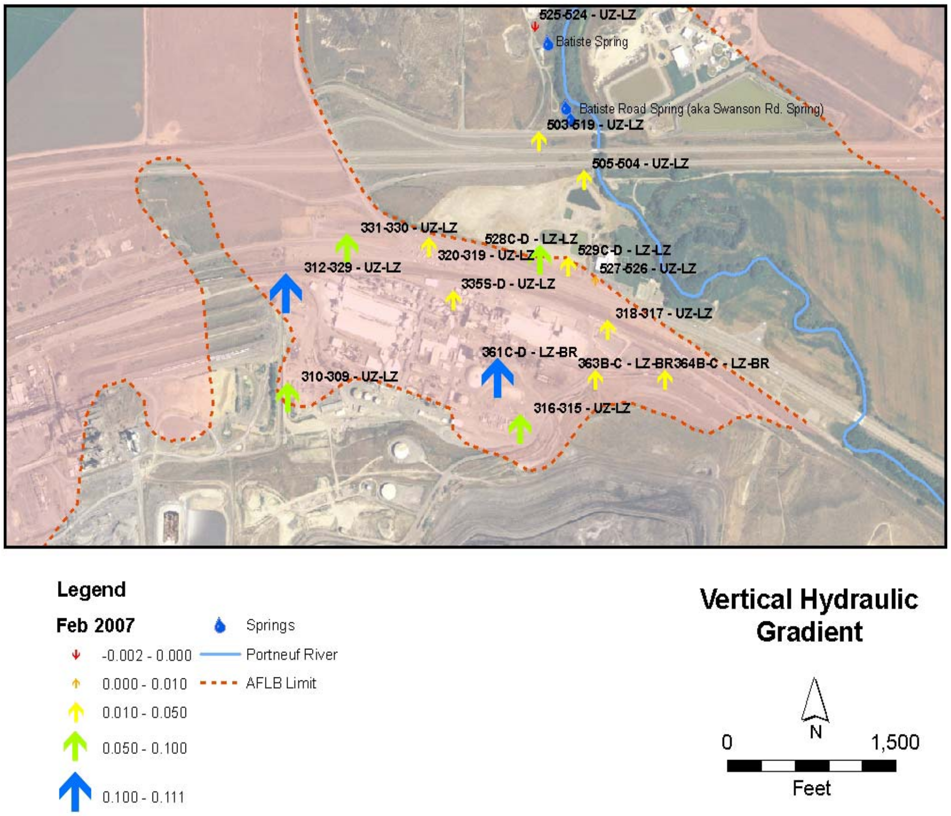

Figure 3-24: Vertical groundwater flow gradients measured at nested wells.

After completion of the Phase 2 Data Gap Investigation (NewFields 2008a), additional monitoring wells were available for inclusion in the groundwater level monitoring program. Beginning in 2006, surface water elevations were measured in the Portneuf River at Highway 30 and Batiste Road concurrently with groundwater levels, allowing the elevation of the surface water in the river to be compared to the groundwater elevation. Groundwater potentiometric surface maps from the second quarter 2008 monitoring event (May 2008) are shown in Figures 3-25, 3-26, and 3-27. Water levels were measured at additional locations at this time and allow the groundwater potentiometric surface in the bedrock to be mapped separately.

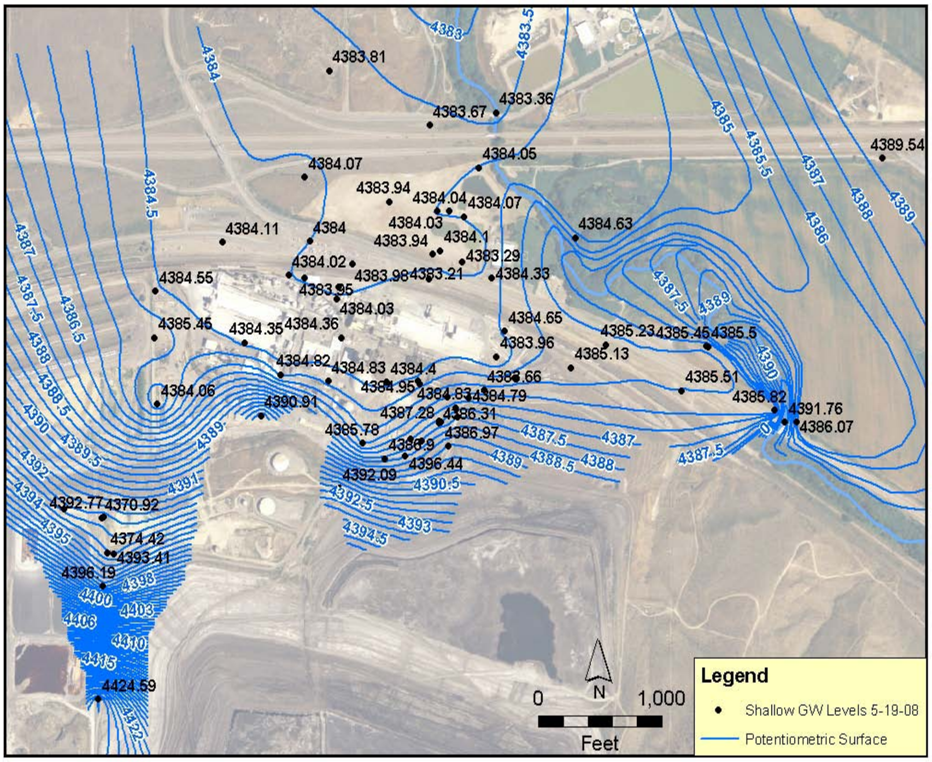

Figure 3-25: Interpreted potentiometric surface for the Upper Zone, second quarter 2008.

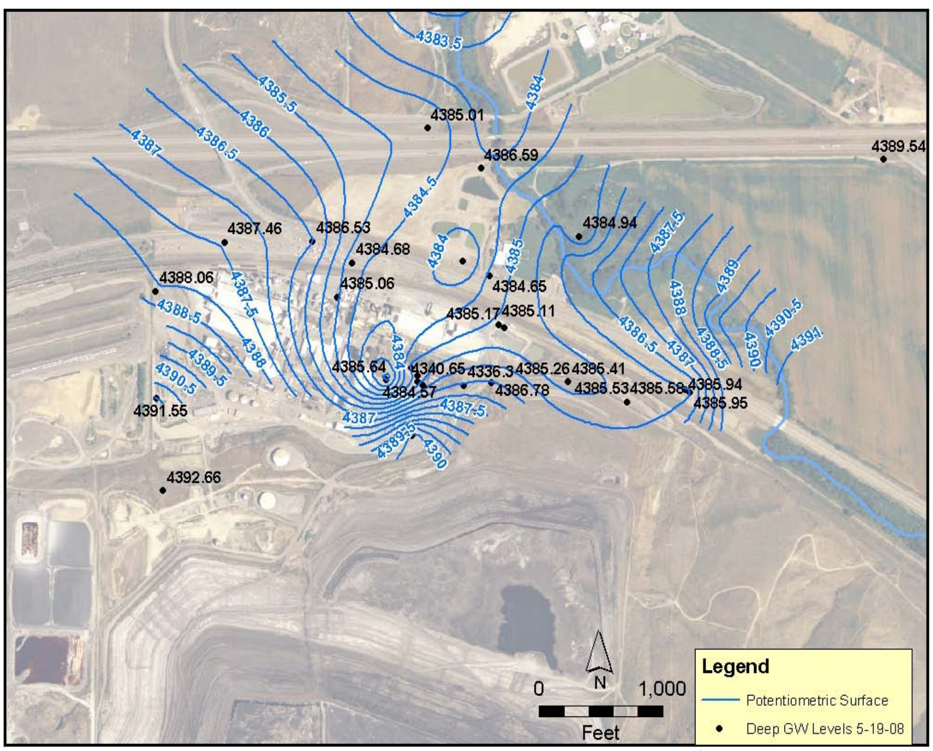

Figure 3-26: Interpreted potentiometric surface for the Lower Zone, May 2008.

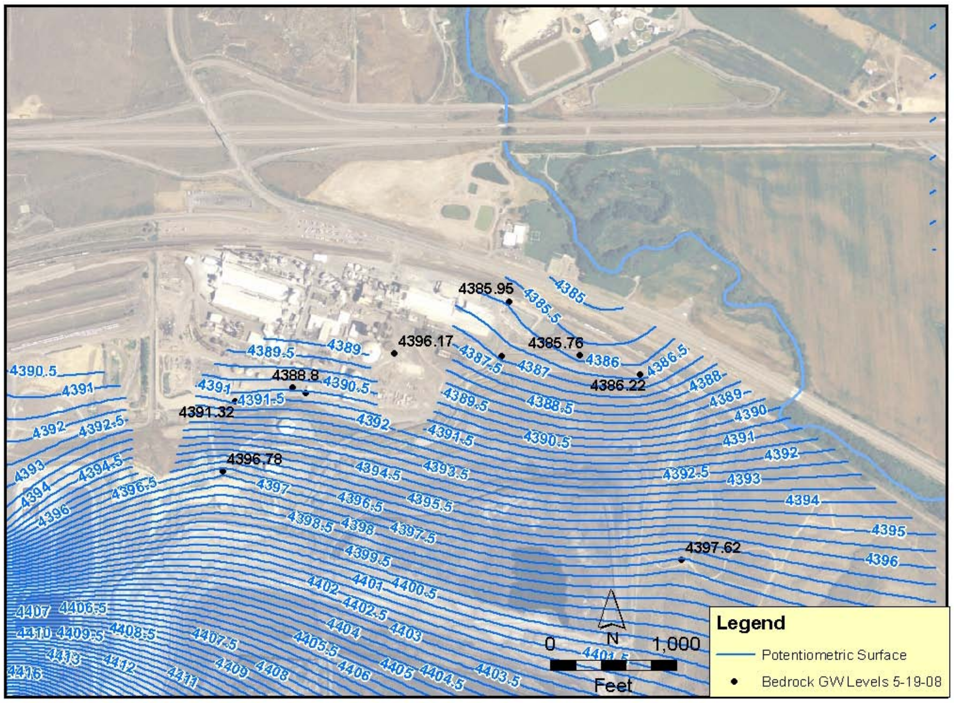

Figure 3-27: Interpreted potentiometric surface for the Bedrock Zone, May 2008.

3.3.3 Surface Water – Groundwater Interaction

The Portneuf River provides a hydraulic boundary to groundwater flow in the Simplot Plant Area and a regional discharge location for groundwater in the area, including groundwater affected by Simplot operations. The profile of the Portneuf River is shown in Figure 3-28. The river transitions from a losing stream to a gaining stream in the vicinity of the I-86 bridge. IDEQ performed a study of water quality impacts to the Portneuf River from 1999 to 2002 and published the results in 2004 (IDEQ 2004). Transect survey locations for the IDEQ study are shown in Figure 3-29. As shown in Figure 3-30 the river gains a significant flow of water from transect T-1 to T-4, and the orthophosphate load to the river peaks at station T-3. This information indicates that discharge of the plume of affected groundwater from the Simplot and FMC sites to the Portneuf River is likely to be concentrated in the river between stations T-1 and T-3.

A plot of the discharge of the Portneuf River at a USGS gaging station near the EMF Site is shown in Figure 3-31. Peak river flows are in the spring (typically early May) and low flows are in the summer (typically August). A plot of the groundwater elevations in the wells along the flow path between the plant facilities and the river are shown in Figure 3-32. Groundwater levels generally do not exhibit strong seasonal fluctuations; however, the very high river flow in May of 2006 correlates with a significant short-term increase in groundwater level.

As shown in Figure 3-33, the river stage elevation at the measuring point at the Highway 30 bridge is typically about 5 feet higher than the groundwater elevation measured in wells nearby.

At the river stage measuring point at the Batiste Road bridge, the river stage elevation is below the groundwater elevation measured in wells nearby. These measurements indicate that the river has a very high potential to lose water at the Highway 30 bridge and the potential to gain water at the Batiste Road bridge. Discharge measurements made in between May 2004 and September 2005 at the Carson Street bridge in Pocatello and the Batiste Road bridge show a very good correlation (Figure 3-34) and indicate that the river loses about 5% of its flow between the two locations.

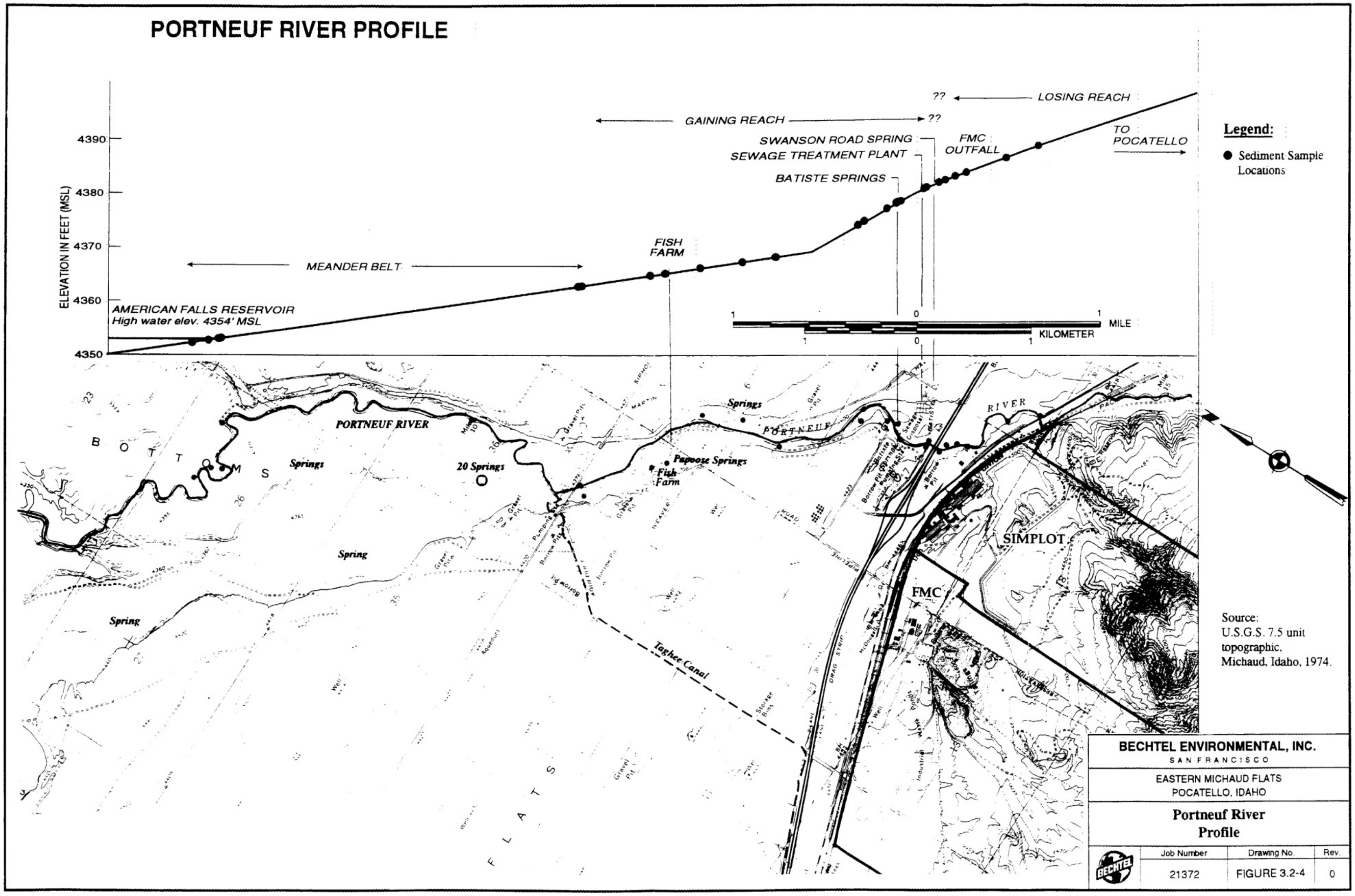

Figure 3-28: The Portneuf River goes from a losing to a gaining stream near the I-86 bridge (Bechtel 1996).

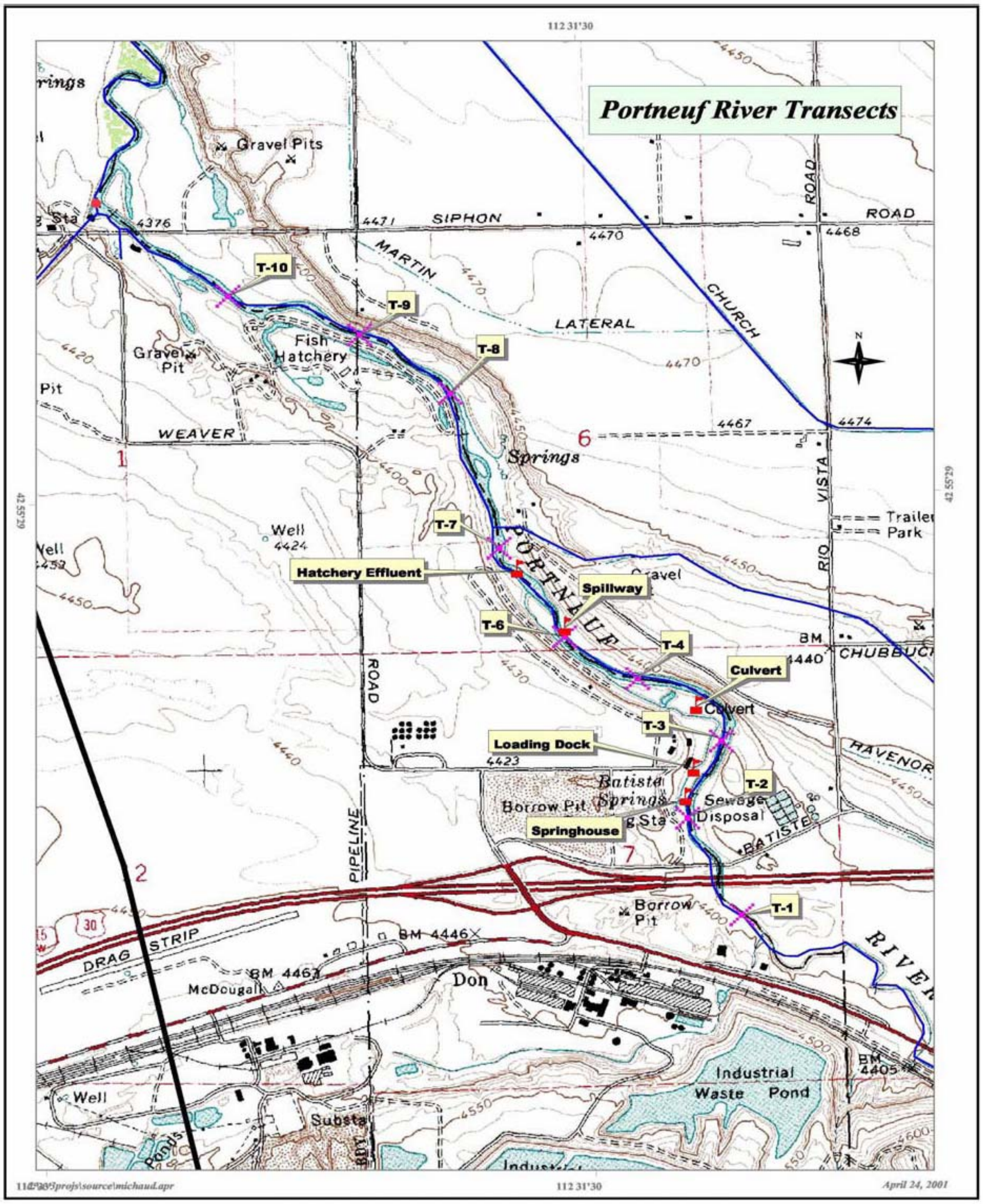

Figure 3-29: From the Idaho DEQ study on the Portneuf River showing survey transect locations (IDEQ 2004).

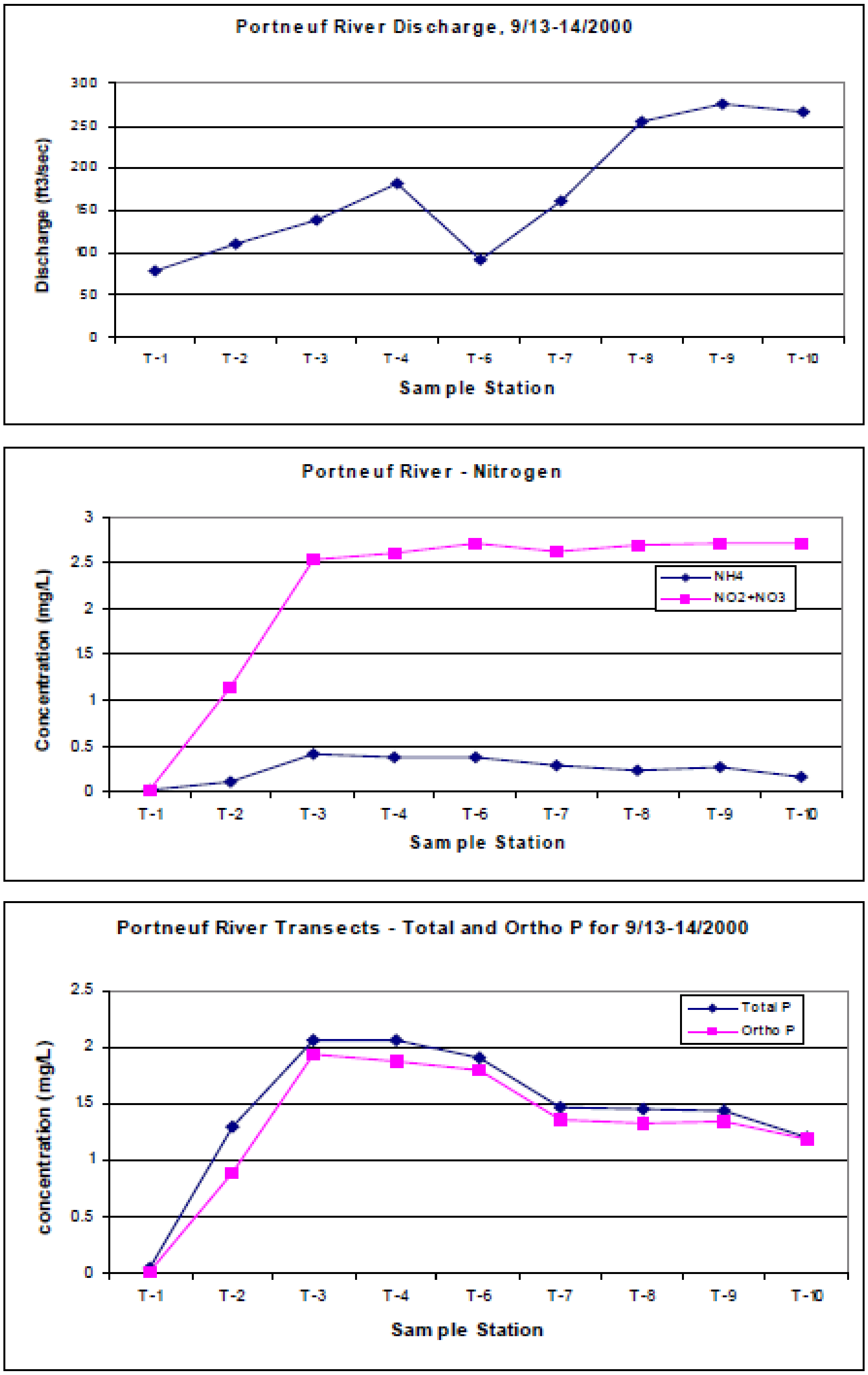

Figure 3-30: IDEQ data from September 2000 (IDEQ 2004, Figure 8).

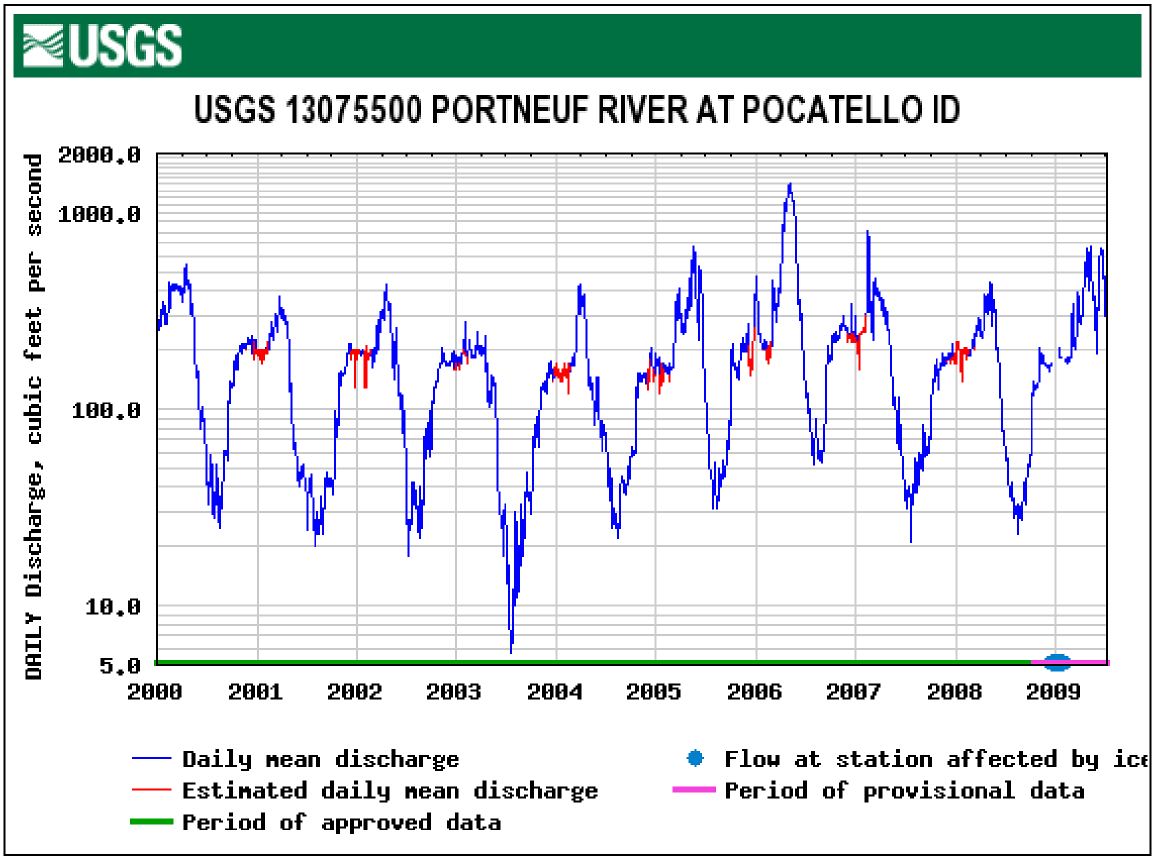

Figure 3-31: Portneuf River discharge at USGS gaging station at the Carson Street Bridge in Pocatello, just upstream of the EMF site.

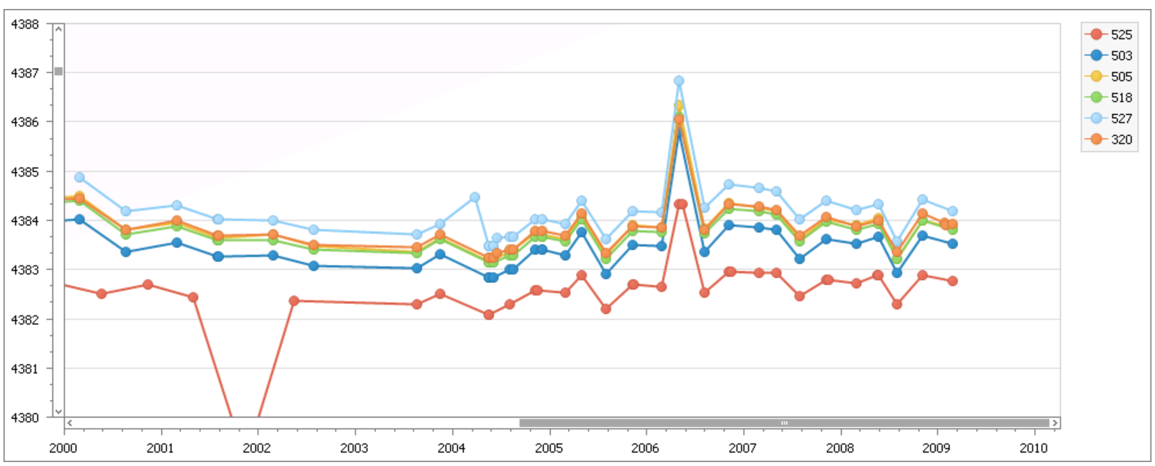

Figure 3-32: Hydrographs of Upper Zone groundwater levels in wells located between the plant facilities and the Portneuf River.

Figure 3-33: River stage elevation at the Highway 30 bridge (PTRA30) and the Batiste Road bridge (PBATR) compared to Upper Zone groundwater elevations in respective wells near each bridge.

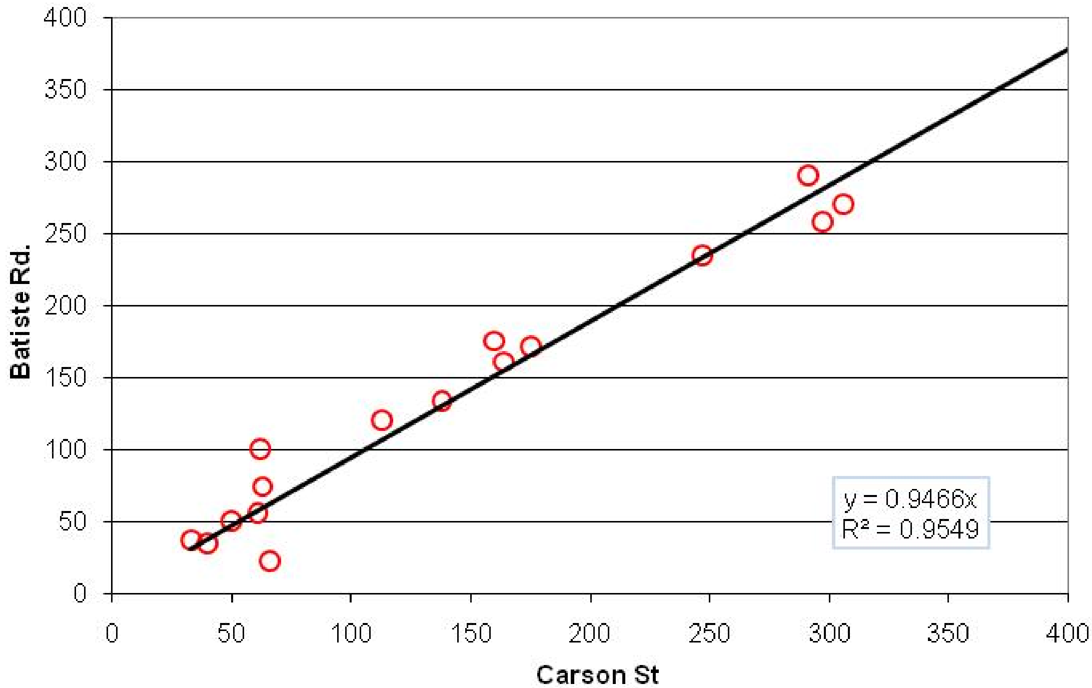

Figure 3-34: Correlation of Portneuf River discharge measured at the Carson Street bridge and the Batiste Road bridge (IDEQ, May 2004 to September 2005).

3.3.4 Nature and Extent of Site-Derived Constituents in Groundwater

Past operations at the FMC and Simplot facilities have affected groundwater quality at the location of operations. In general, groundwater flowing north from the Bannock Range mixes with groundwater affected by site activities, resulting in increased constituent concentrations. As the affected groundwater travels away from the Bannock Range, it moves from the volcanic bedrock of the mountains through clay-rich alluvial fan deposits then into coarse-grained alluvial deposits. Ultimately the affected groundwater discharges to the Portneuf River through springs and channel bank baseflow.

North of Highway 30, the plume of affected groundwater migrates within the alluvial deposits and becomes diluted as it mixes with unaffected groundwater in a zone of high hydraulic conductivity. The affected groundwater may be traveling within preferential flow zones and/or the plume location may be affected by the nearby losing reach of the Portneuf River south of the I-86 bridge. As a result, existing monitoring wells may not be optimally located and/or screened at the appropriate depth interval to intercept the axis of the plume. A groundwater geophysical investigation was performed to aid in delineating the extent of site-affected groundwater in the area between Highway 30 and the Portneuf River.

3.3.4.1 Sources of Groundwater Contamination

There are two general sources that affect groundwater quality in the Simplot Plant Area 1) seepage from the gypsum stack and 2) releases from processing areas.

As described in Section 3.2, seepage from the gypsum stack is estimated to be about 900 gpm. This seepage contains high concentrations of arsenic, sulfate and orthophosphate. The seepage migrates downward through unsaturated strata beneath the gypsum stack eventually comingling with regional Bannock Range groundwater derived from recharge areas (see Section 3.3.1). Groundwater profile sampling conducted during the Phase 2 Data Gap Investigation (NewFields 2008a) indicates that stack-affected groundwater is present within the bedrock at the toe of the gypsum stack and is discharging upward into the unconsolidated strata of the Upper and Lower Zones.

Sources from processing areas include the former Nitrogen Solutions Plant and the Phosphoric Acid Plant. Historic releases from the Former East Overflow Pond, which was unlined, were identified during the RI, but were mitigated through the installation of a lined pond. Sources in the Phosphoric Acid Plant have been observed to result in high concentrations of orthophosphate and arsenic and low pH in Upper Zone monitoring wells completed north of the plant (wells 340, 367 and 320). A mitigation program has been in place since March 2007 and has included many major repairs to the plant along with weekly groundwater monitoring at wells 367 and 340. Monthly monitoring and progress reports have been provided to IDEQ and EPA since the program began. A subsurface investigation was completed in the PAP Area in accordance with a work plan approved by EPA and IDEQ (NewFields 2008d).

Upgradient of the PAP Area, concentrations of arsenic, phosphorus and sulfate in groundwater are consistent with levels associated with the gypsum stack (Figure 3-35). Based on data obtained prior to the completion of the recent subsurface investigation, phosphorus concentrations in upgradient groundwater originating in the southeastern portion of the plant area, at the toe of the gypsum stack, have ranged from about 18 to 680 mg/L with a mean of 260 mg/L (Figure 3-36). Concentrations in upgradient groundwater originating in the south and southwestern portion of the plant area have ranged from non-detected to about 68 mg/L with a mean of 19 mg/L (Figure 3-37). The total phosphorus concentrations in wells 340, 335S, 367, 369 and 419, within the PAP Area, have at times been higher than would be expected for stack impacts alone, indicating the presence of a distinct facility-related source or sources (see Figures 3-36 and 3-37).

The results of the PAP subsurface investigation (Simplot 2009), indicate that the source term for phosphorus in the PAP Area is the sum of the direct infiltration of acidic process liquids from releases and the infiltration of non-process related liquids (precipitation and storm water) that have leach phosphorus from precipitates within the unsaturated zone. Since the potential for loading by infiltration of precipitation through the vadose zone and recharge to groundwater is very low, essentially all of the phosphorus observed in groundwater downgradient of the PAP Area is due to releases of acidic process liquids and direct migration to groundwater.

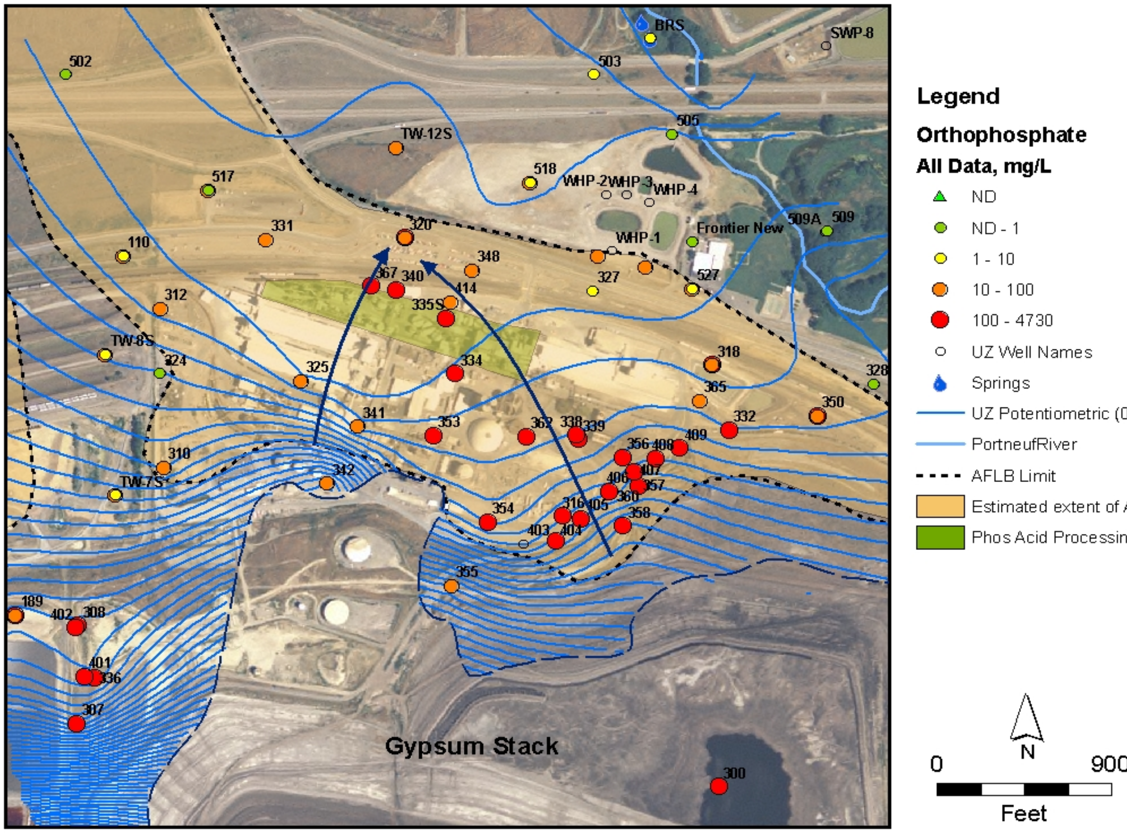

Figure 3-35: Historical concentrations of total phosphorus in Upper Zone groundwater (November 2007 potentiometric surface shown)

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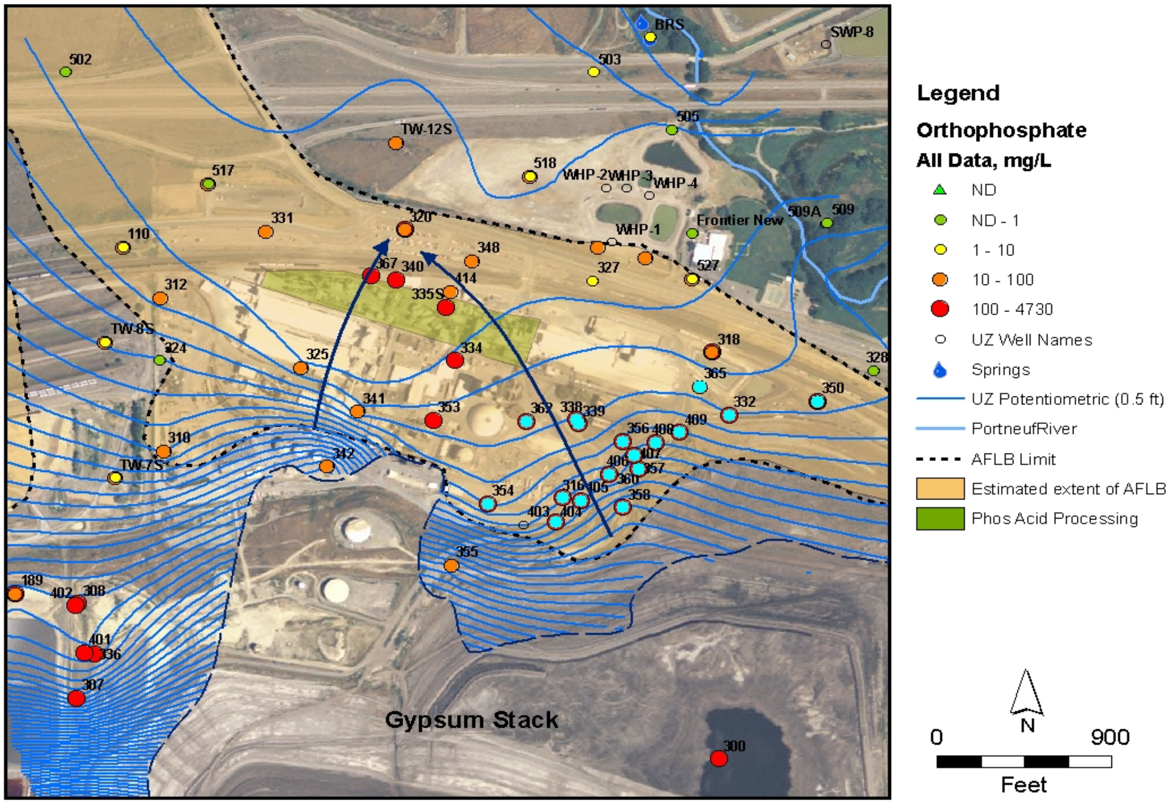
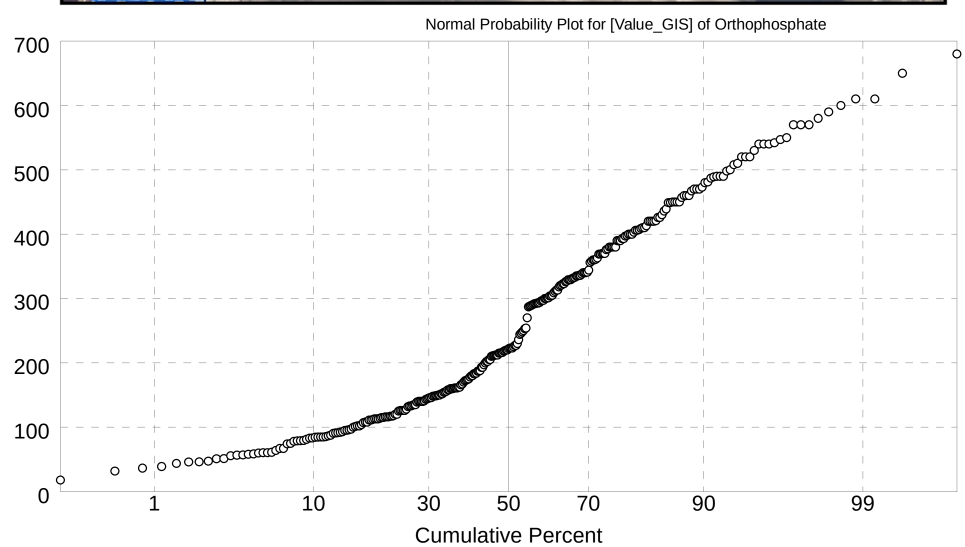
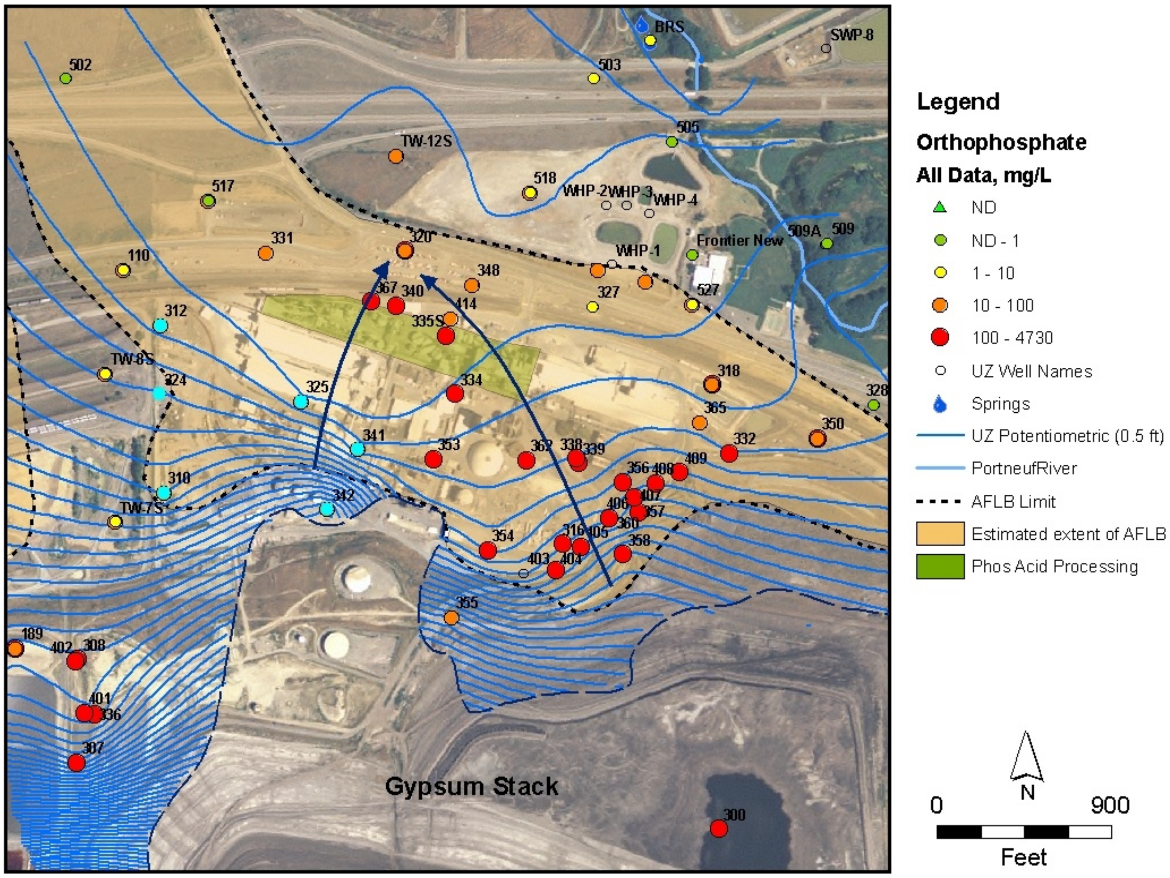


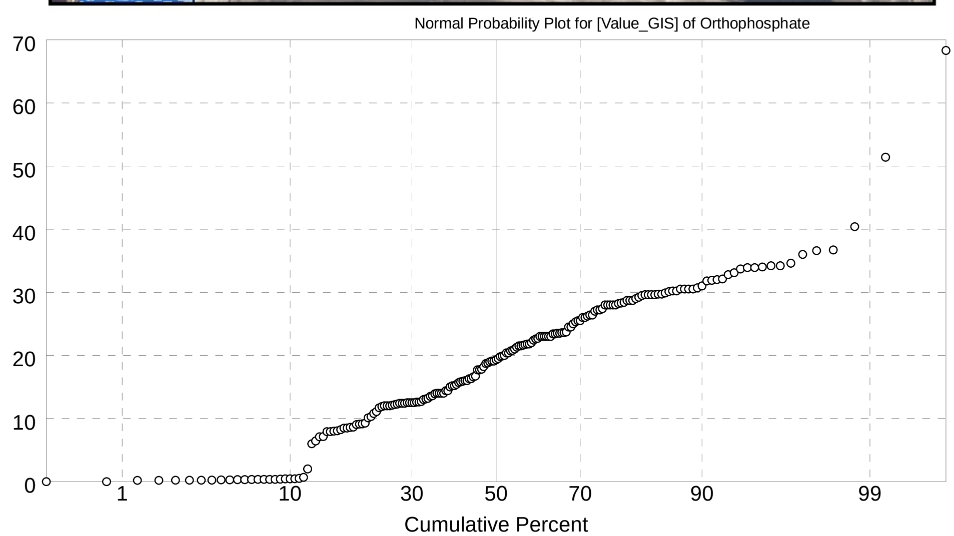


Count	309
Minimum	17.8
Maximum	680.0
Sum	80319.3
Mean	259.933
Median	222.0
StdDev	152.6736
Variance	23309.23
Skewness	0.4772031
Kurtosis	-0.7927236
95 UCL	274.2203

Figure 3-36: Distribution of total phosphorus concentrations (mg/L) downgradient of the gypsum stack in the East Plant. Selected wells are shown in light blue.

Note: All data through 2008Q2 sampling are included. On map, the maximum values are shown at each well. On probability plot, all data are shown.





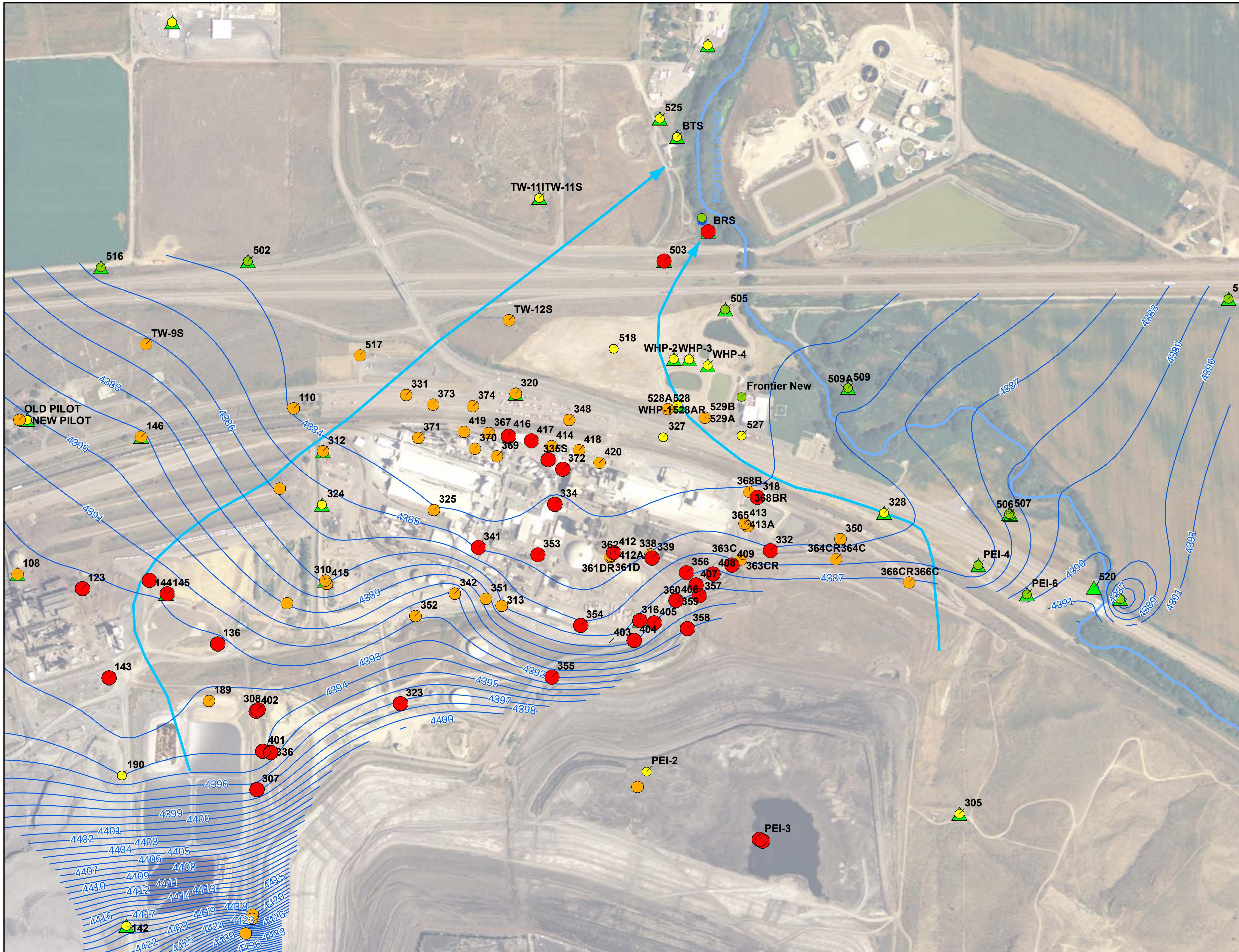
Count	195
Minimum	0
Maximum	68.3
Sum	3665.234
Mean	18.79607
Median	19.3
StdDev	11.06744
Variance	122.4882
Skewness	0.3278798
Kurtosis	1.109082
95 UCL	20.09983

Figure 3-37: Distribution of total phosphorus concentrations (mg/L) downgradient of the gypsum stack in the West Plant. Selected wells are shown in light blue.

Note: All data through 2008Q2 sampling are included. On map, the maximum values are shown at each well. On probability plot, all data are shown.

3.3.4.2 Extent of Site-Derived Constituents in Groundwater

The horizontal extent of arsenic in the Upper and Lower Zone groundwater is shown in Figures 3-38 and 3-39. The western extent of stack-affected groundwater (blue line in Figure 3-38) was delineated in part by using isotope data obtained by the IDEQ (IDEQ 2004). The horizontal extent of phosphorus in Upper and Lower Zone groundwater is shown in Figures 3-40 and 3-41.



Legend

Arsenic, Total (mg/L), All Data

Max

- ND
- < 0.010 (MCL)
- 0.011 - 0.050
- 0.051 - 0.400
- 0.401 - 2.920
- Springs
- Upper Zone Potential, Aug. 2003
- UZ Extent
- Portneuf River

N

Feet

0 500 1,000

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FIGURE 3-38

TOTAL ARSENIC IN THE UPPER ZONE, ALL DATA

PROJ: #009-002	DATE: NOV 10, 2009
REV: 0	BY: TRA CHECKED: BC

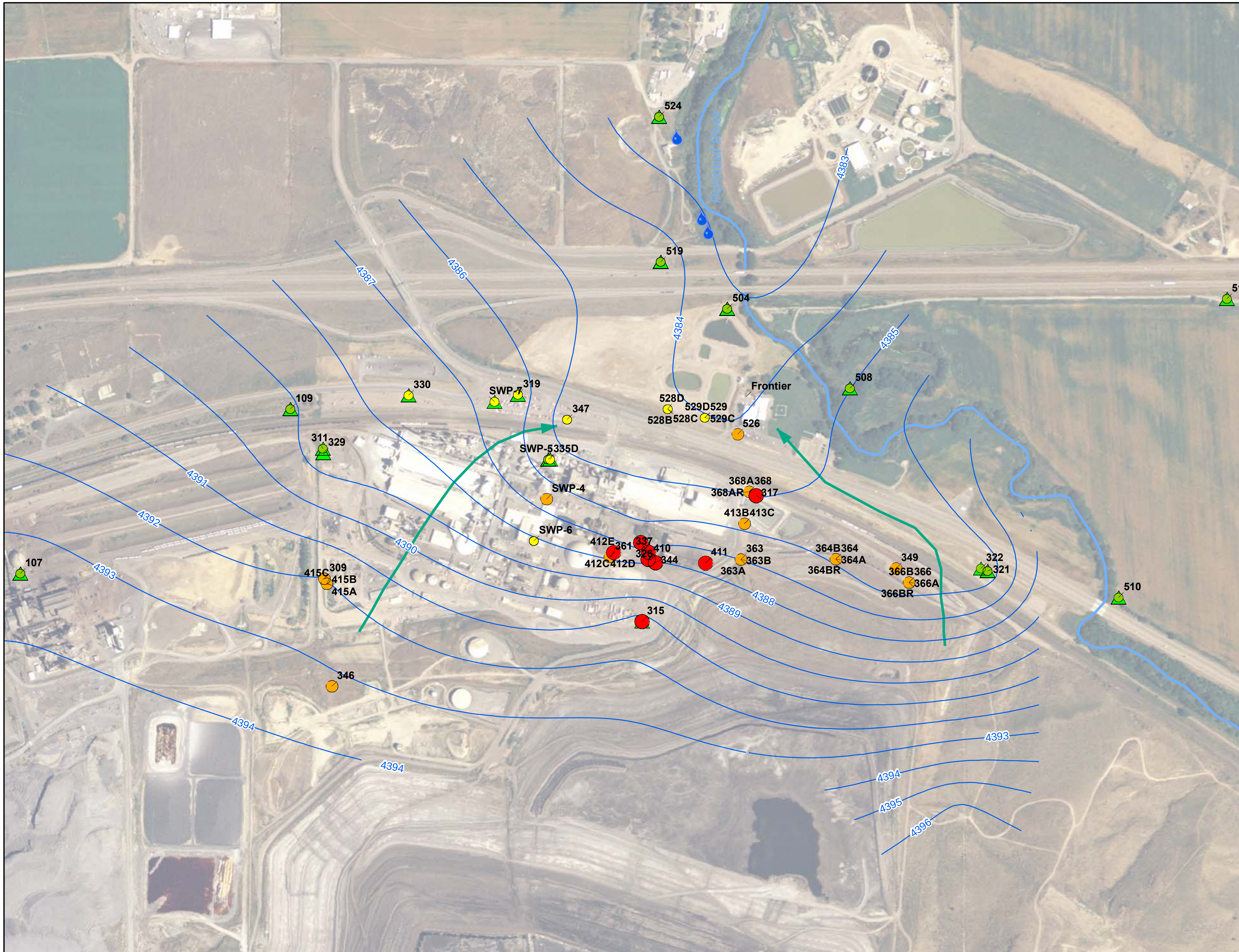

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FIGURE 3-39

TOTAL ARSENIC IN THE LOWER ZONE, ALL DATA

PROJ: #009-002	DATE: NOV 10, 2009	
REV: 0	BY: TRA	CHECKED: BC

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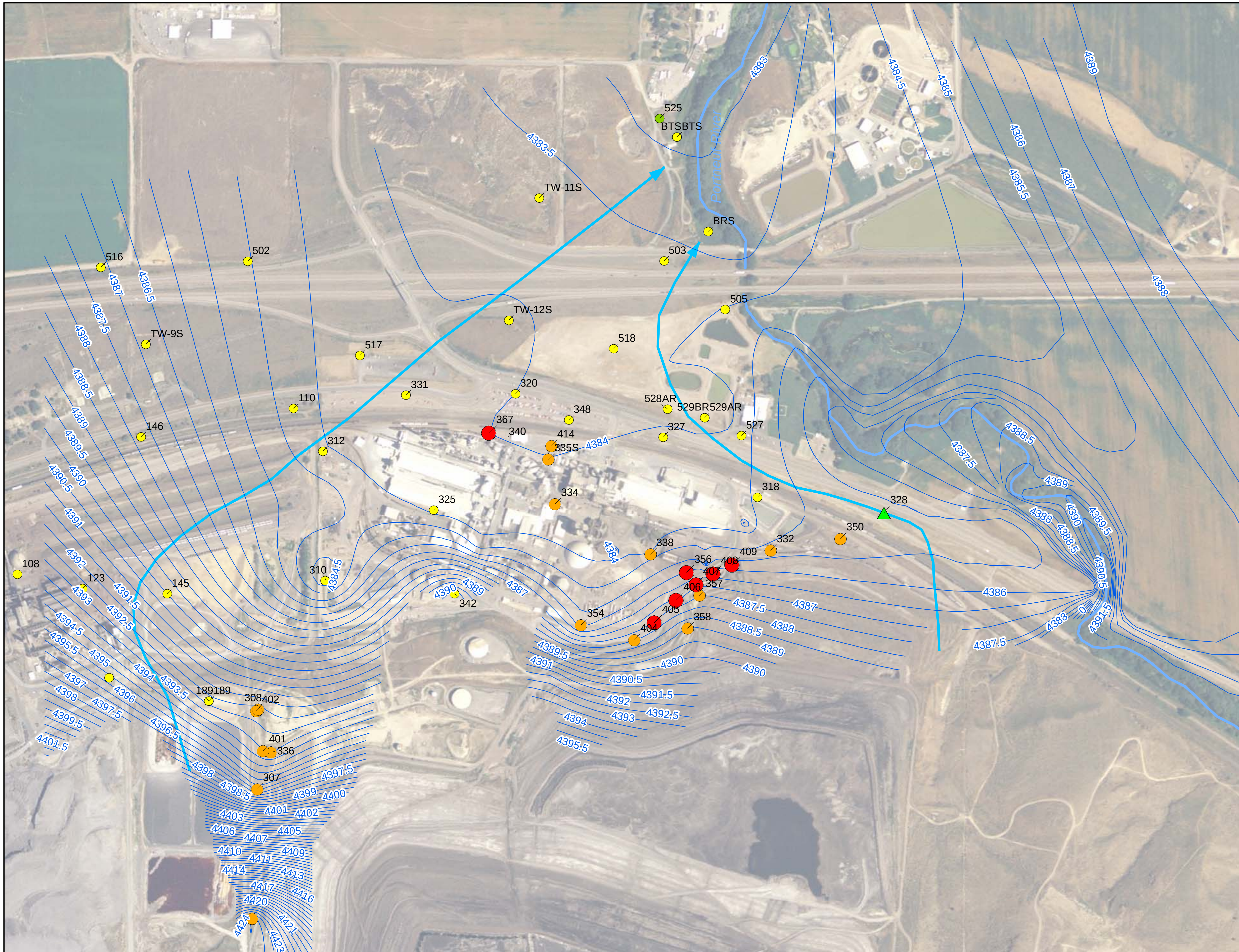


Legend

Orthophosphate, as Total P (mg/L)

Value_GIS

- ND
- < 0.075
- 0.075 - 100
- 101 - 300
- 301 - 5600
- Potentiometric Surface, UZ May 2008
- UZ Extent
- Portneuf River

N

Feet

0 500 1,000

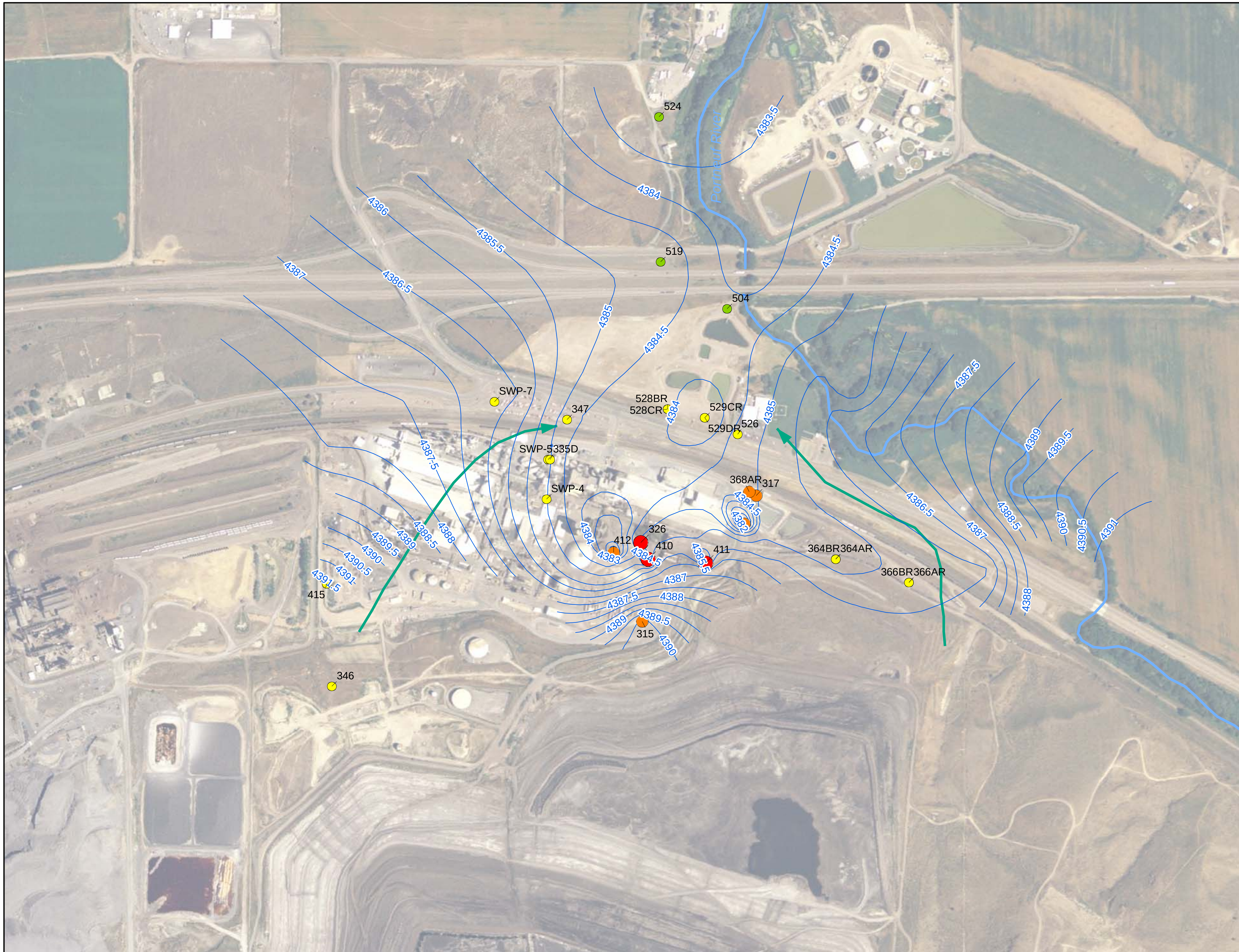
J.R. SIMPLOT

EASTERN MICHAUD FLATS

FIGURE 3-40

ORTHOPHOSPHATE as TOTAL P, IN THE UPPER ZONE, 2008Q2

PROJ: #009-002	DATE: NOV 10, 2009	
REV: 0	BY: TRA	CHECKED: BC



Legend

Orthophosphate, as Total P (mg/L)

Value_

- ND
- < 0.075
- 0.075 - 100
- 101 - 300
- 301 - 7000
- Potentiometric Surface, LZ May 2008
- LZ Extent
- Portneuf River

N

Feet

0 500 1,000

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EASTERN MICHAUD FLATS

FIGURE 3-41

ORTHOPHOSPHATE as TOTAL P, IN THE LOWER ZONE, 2008Q2

PROJ: #009-002	DATE: NOV 10, 2009	
REV: 0	BY: TRA	CHECKED: BC

Stack-affected groundwater flows north from the toe of the gypsum stack in the Upper and Lower Zones. Numerous investigations support the hypothesis that all affected groundwater discharges to the river in a short reach north of the I-86 bridge and Batiste Springs. The reach of the Portneuf River south of I-86 is losing. As constituents migrate north and northeast, concentrations are diluted due to mixing with unaffected groundwater in a zone of high hydraulic conductivity. Affected groundwater in the Lower Zone depth is forced upward by the strong upward hydraulic gradient (Figure 3-24). The source of unaffected groundwater is regional flow from the prolific basalt and gravel aquifers underlying Michaud Flats to the west and down valley underflow from the Pocatello Valley aquifer to the east. These aquifers are recharged by underflow from the adjoining Bannock and Pocatello mountain ranges and direct infiltration from precipitation and irrigation return.

A portion of the regional cross section 3 (Figure 3-6) is shown in Figure 3-42. As groundwater migrates north of Hwy 30, it enters the region where the coarse-grained alluvial materials of the Upper Zone (Michaud Formation [Qm]) and underlying Lower Zone (Sunbeam Formation [Qsu]) merge into a continuous hydraulic unit. In the plant areas, the two formations are separated by the AFLB.

As shown in Figures 3-43 and 3-44, the lower limit of affected groundwater decreases in depth from south to north due to the upward hydraulic gradient and the termination of the AFLB clay unit. Specific conductance of the affected groundwater drops from over 2500 uS/cm in groundwater samples collected from wells south of Hwy 30 to less than 1500 uS/cm in samples from wells to the north of Hwy 30 (Figure 3-45). The conductance of the affected groundwater within the plume, as measured in samples from wells 518 and 503, is about 1200 uS/cm, which is about twice the conductance of background groundwater.

Time-series plots of arsenic, sulfate and phosphate concentrations in groundwater samples from wells along a flow path from the Simplot facilities to the river are shown in Figure 3-46. Batiste Road Spring (BRS) and Batiste Spring (BTS) are two prominent springs that are located on the west bank of the river in the discharge area. Time-series plots of arsenic and phosphate concentrations in spring samples are shown in Figure 3-47. Trends in spring samples exhibit some seasonal variability that is not seen in the groundwater samples from wells 518 and 503, which are located within the affected groundwater plume.

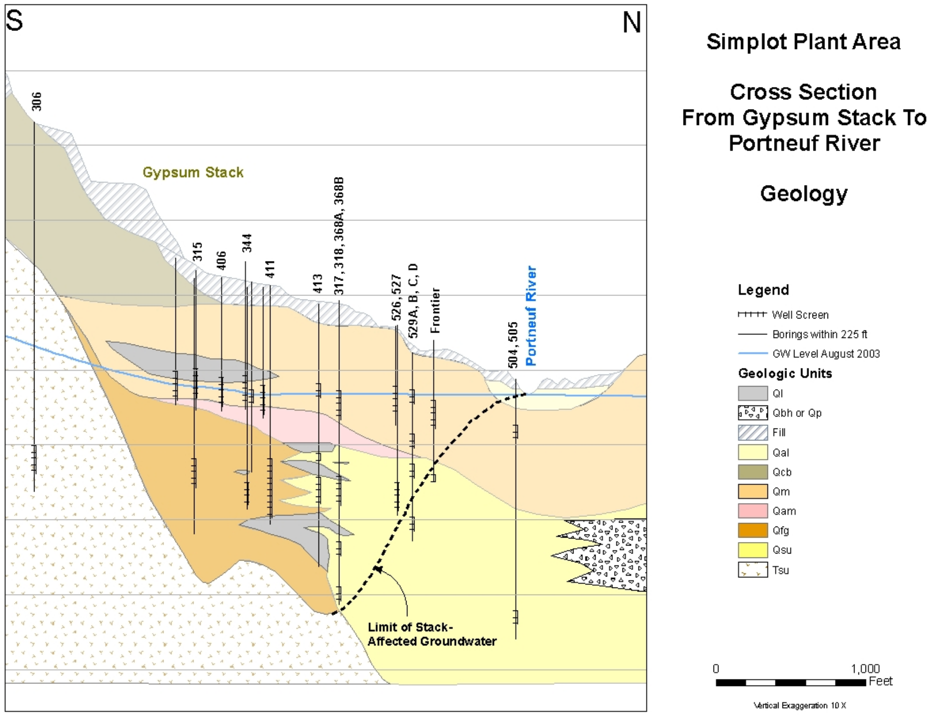

Figure 3-42: Portion of Regional Section 3 showing gelogic units.

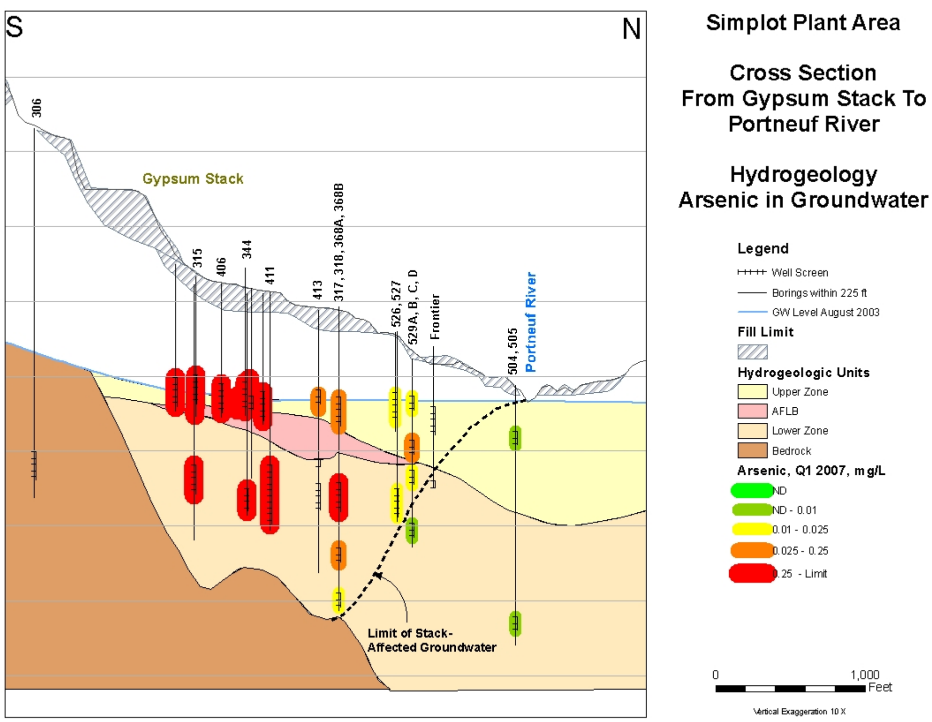

Figure 3-43: Portion of Regional Section 3 showing distribution of arsenic in groundwater.

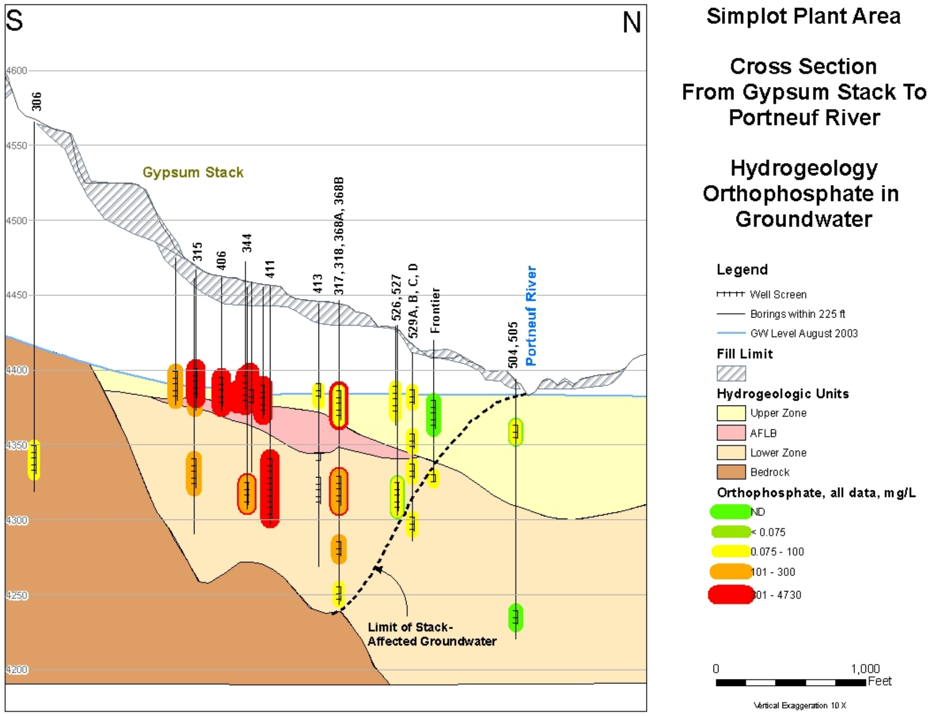

Figure 3-44: Portion of Regional Section 3 showing distribution of phosphorus in groundwater.

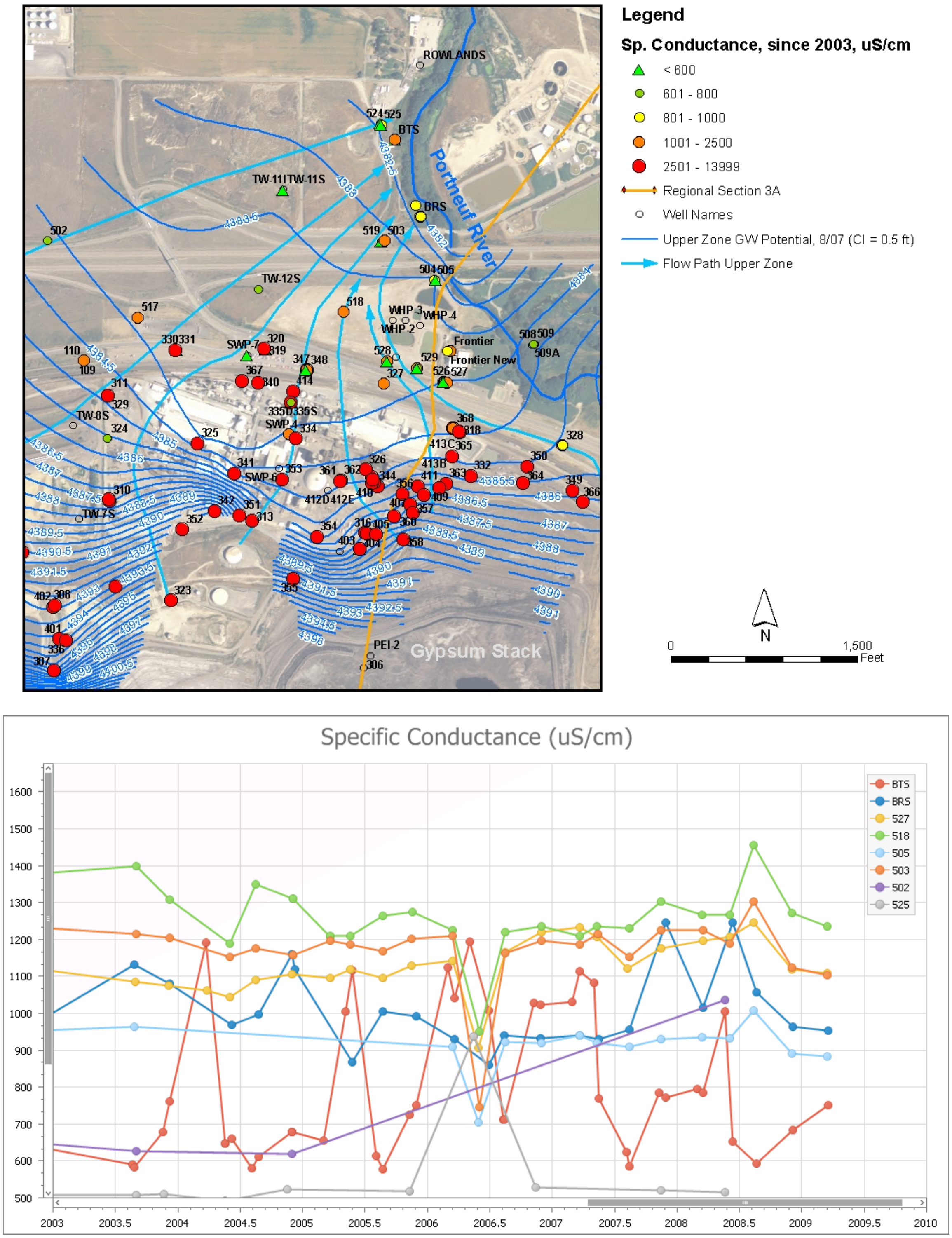

Figure 3-45: Field measurements of specific conductance in groundwater samples collected from wells in the investigation area.

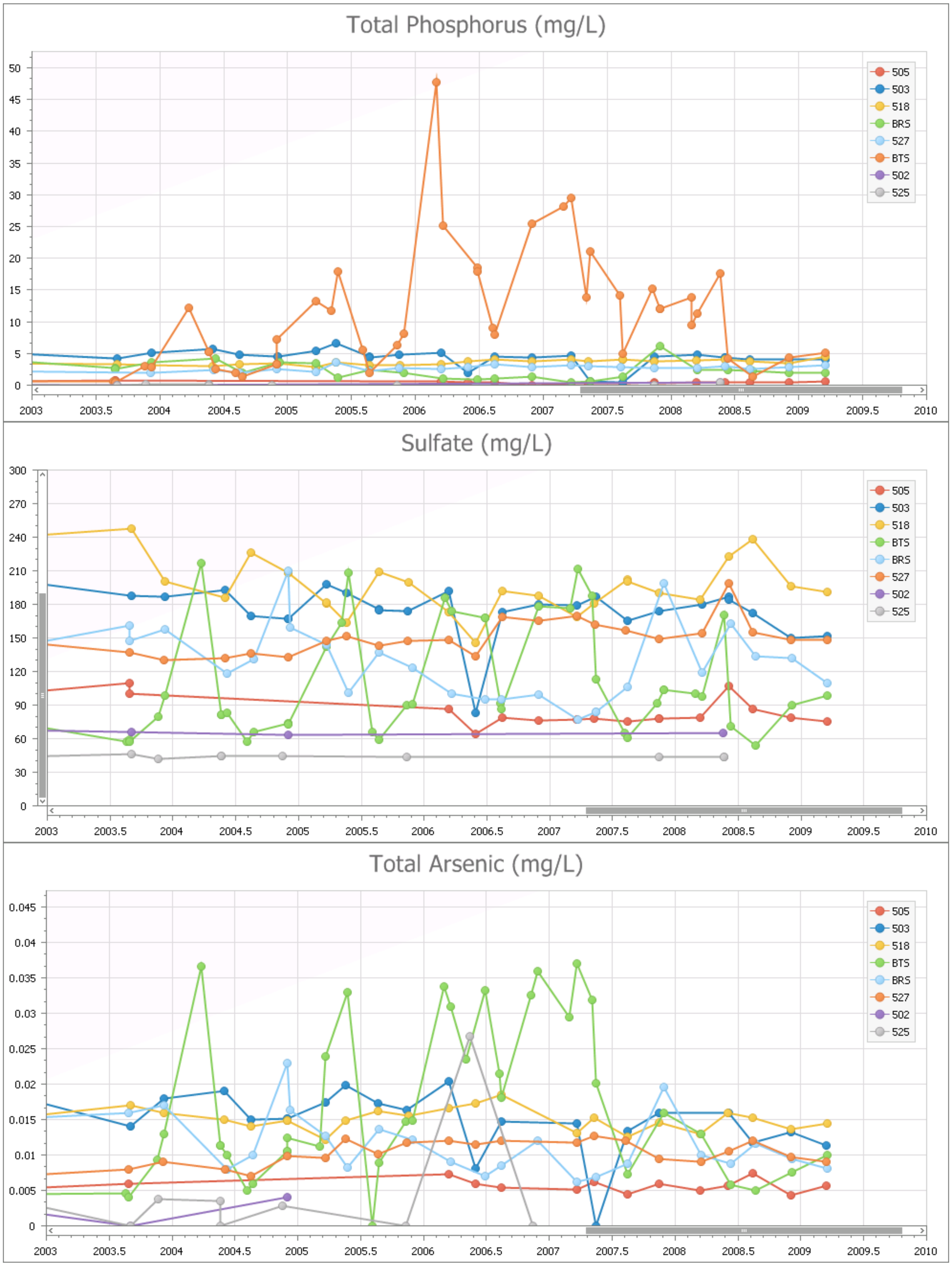

Figure 3-46: Groundwater concentrations in monitoring wells north of Hwy 30 in the flow path to the springs.

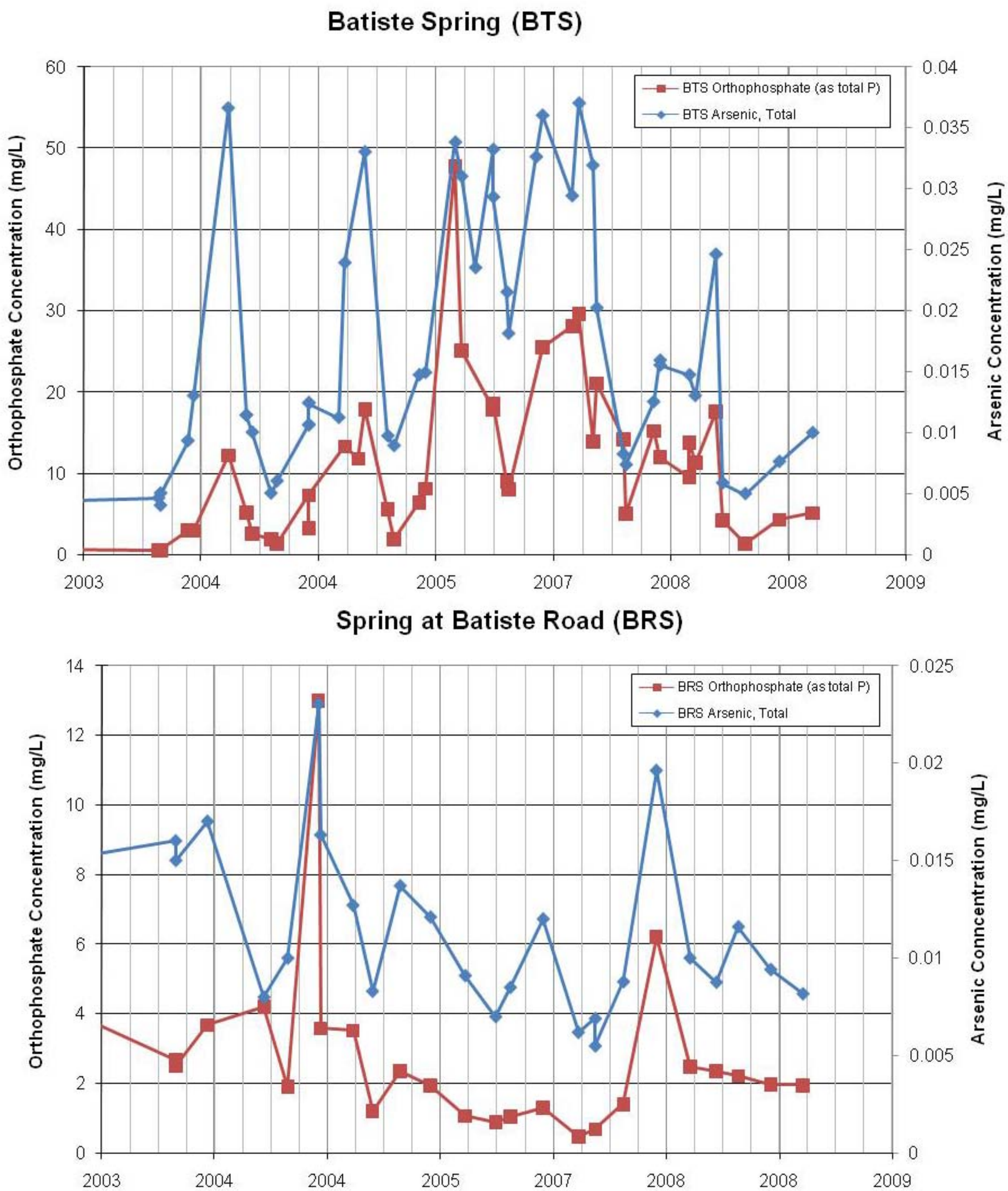

Figure 3-47: Concentrations at the Batiste Springs at the Portneuf River.

The exact configuration of the plume in the area between Highway 30 and the Portneuf River cannot be defined in this area based on the current monitoring well network. A groundwater geophysical survey was therefore conducted in the summer of 2008 with the objective of delineating the plume based on the presence of groundwater with high specific conductance, which is an indicator of stack-affected groundwater. The results of this survey are summarized in a separate draft report (NewFields 2008c).

Eight resistivity profile surveys were completed during the survey (Figure 3-48). The resistivity profile lines 2B, 3 and 5 (located near Interstate 86) may be interpreted to indicate that the flow of high conductance groundwater is being constricted to a narrow zone only a few hundred feet wide. Resistivity profiles were plotted along with recent groundwater specific conductance data from groundwater samples. The resulting profiles for lines 3 and 5 are shown in Figures 3-49 and 3-50. By aligning areas of low resistivity observed in the profiles, a map of the extent of high specific conductance groundwater was made (Figure 3-51).

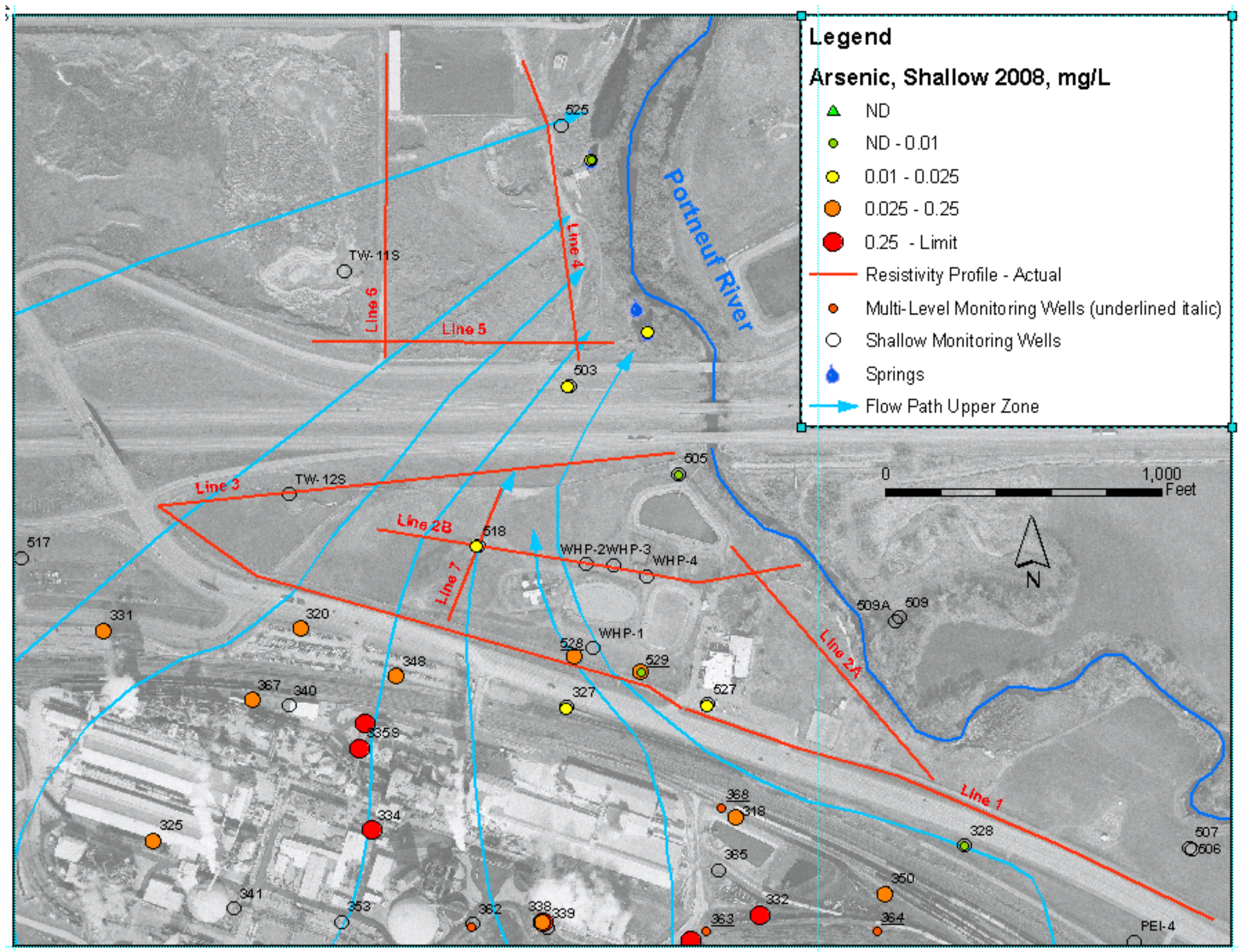

Figure 3-48: Location of resistivity survey lines.

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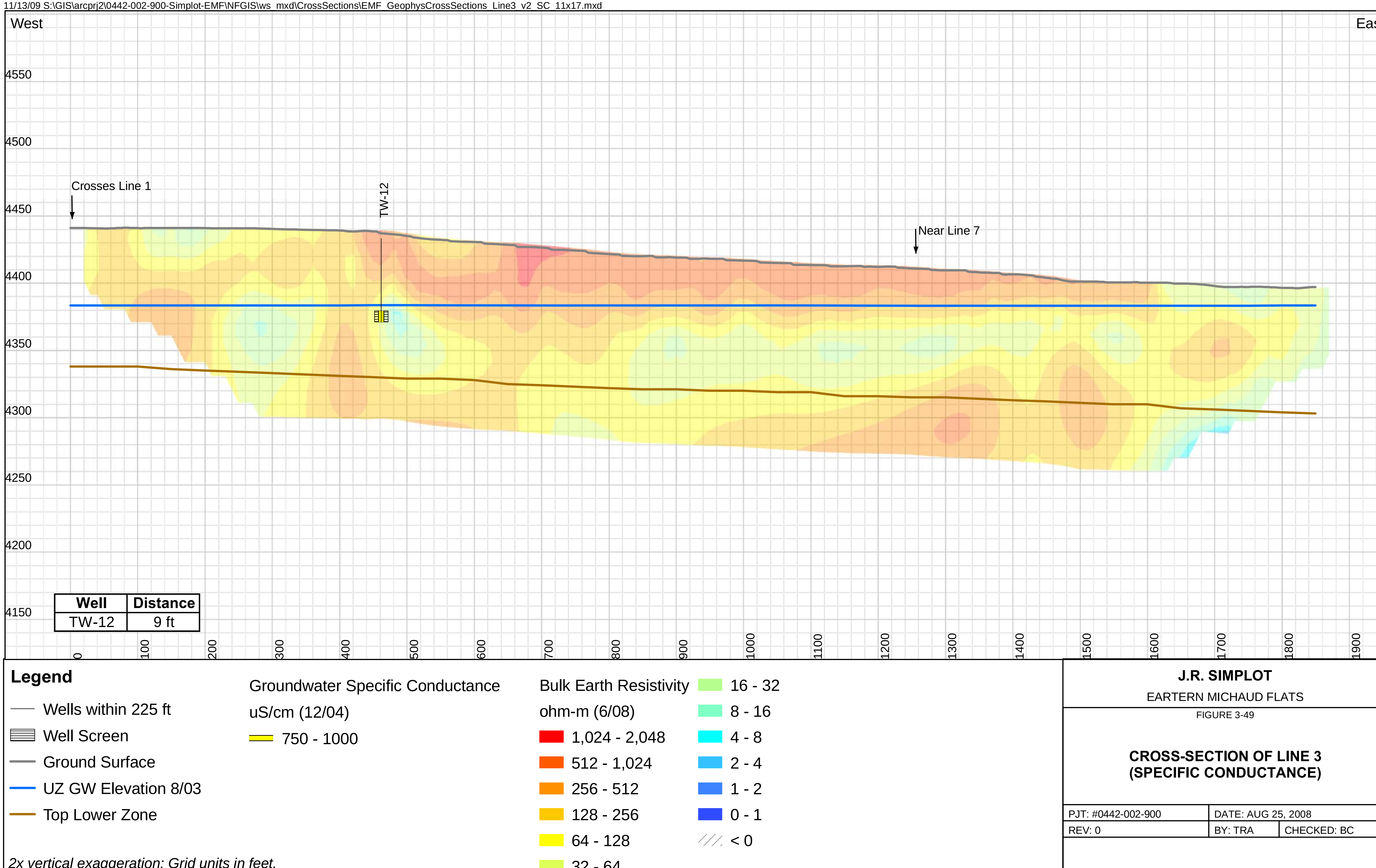

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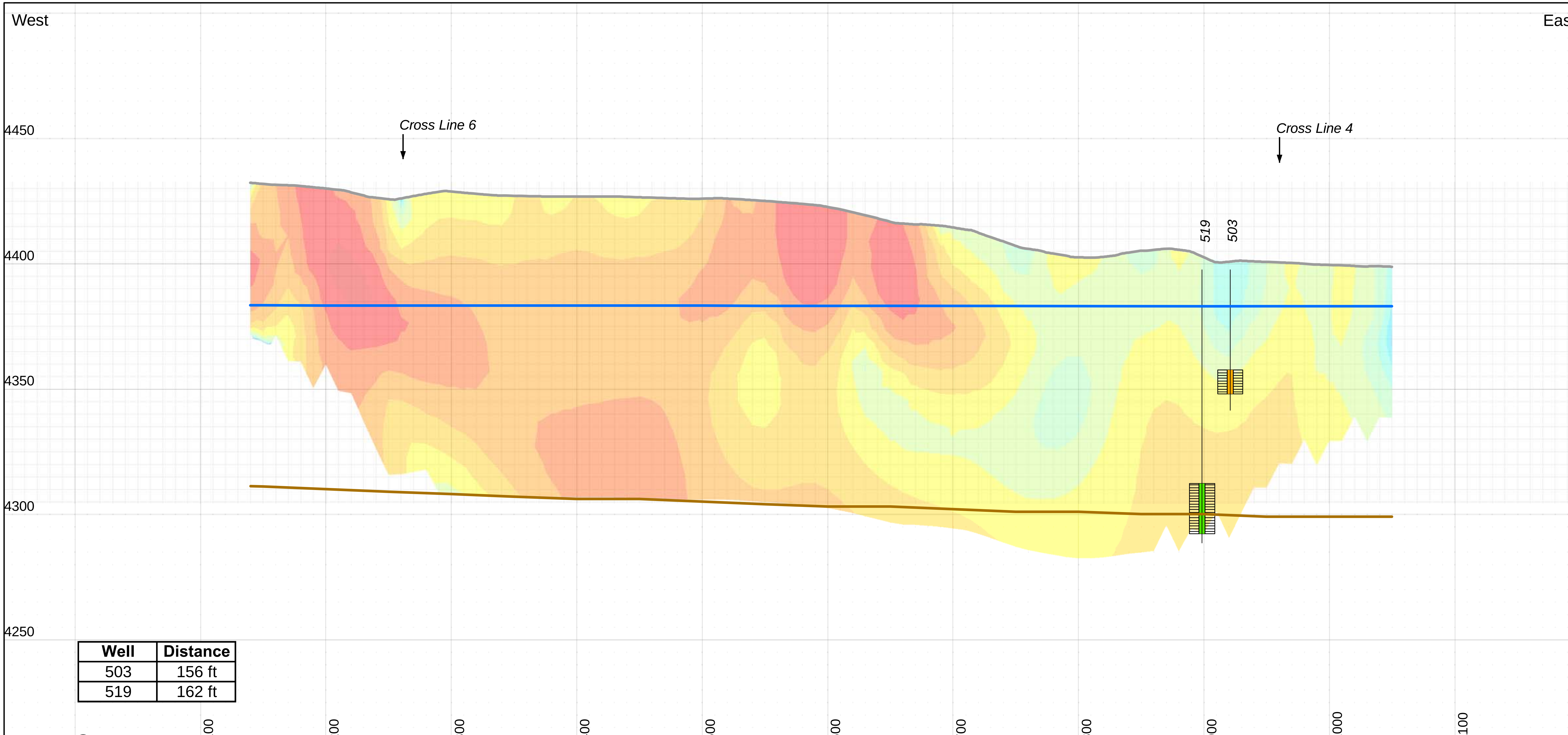


Well	Distance
503	156 ft
519	162 ft

Legend

- Wells within 225 ft
- Well Screen
- Ground Surface
- UZ GW Elevation 8/03
- Top Lower Zone

Specific Conductance uS/cm (6/08)

- 500 - 750
- 750 - 1000
- 1000 - 2000

Bulk Earth Resistivity ohm-m (6/08)

- 2,048 - 4,096
- 1,024 - 2,048
- 512 - 1,024
- 256 - 512
- 128 - 256
- 64 - 128
- 32 - 64
- 16 - 32
- 8 - 16
- 4 - 8
- 2 - 4
- 1 - 2
- 0 - 1
- < 0

2x vertical exaggeration; Grid units in feet.

J.R.SIMPLOT

EASTERN MICHAUD FLATS

FIGURE 3-50

CROSS-SECTION LINE 5 (SPECIFIC CONDUCTANCE)

PJT: #0442-002-900	Nov 13, 2009	
REV: 0	BY: TRA	CHECKED: BC

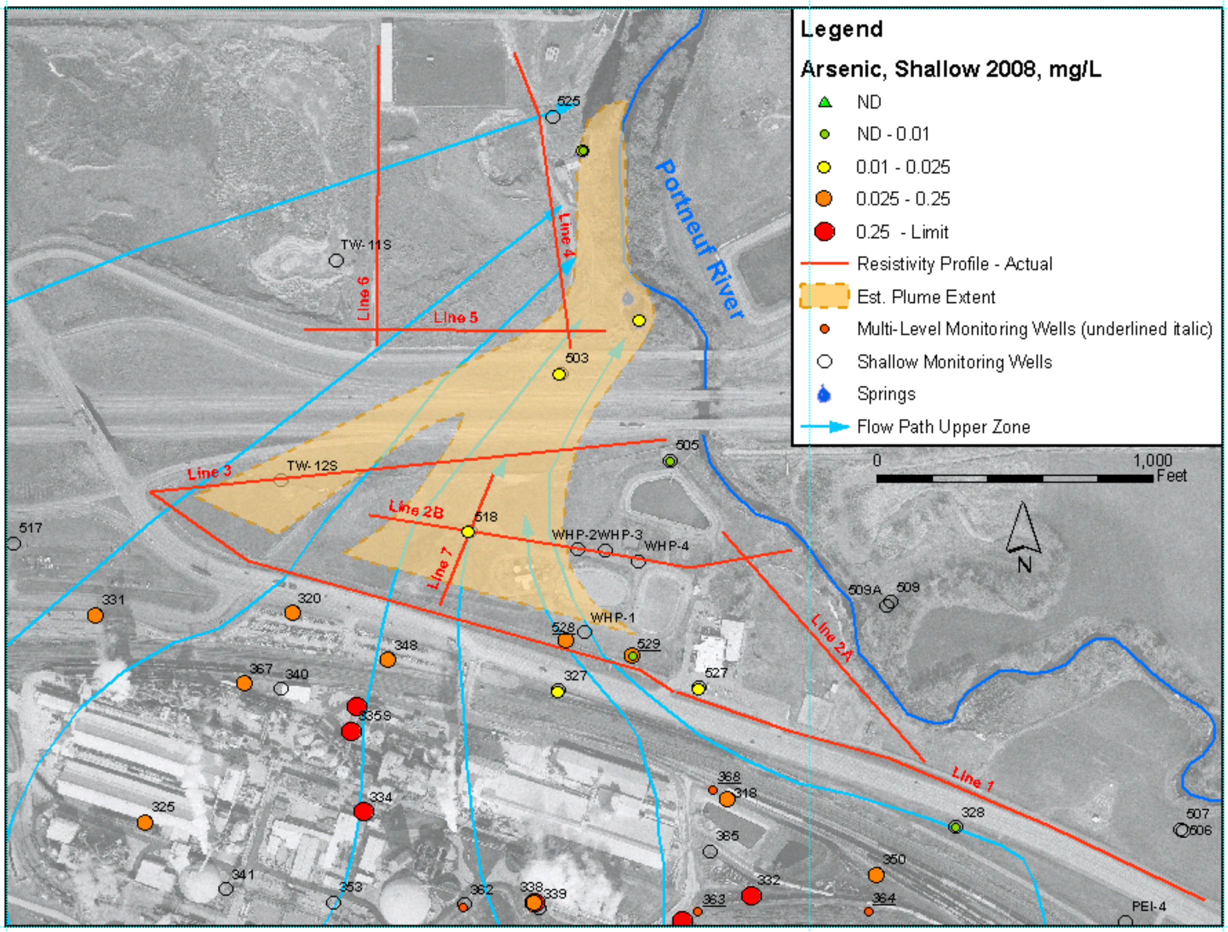


Figure 3-51: The extent of high conductance groundwater as interpreted from the groundwater geophysical data.

3.3.4.2.1. Phosphorus Concentration Trends in Groundwater Influenced by the Gypsum Stack

Phosphorus concentration trends in groundwater influenced only by gypsum stack seepage are assessed by the series of monitoring wells that have been installed in the Upper, Lower, and Bedrock Zones between the toe of the gypsum stack and the processing facility. As shown in Figures 3-52 and 3-53, the concentration of phosphorus in the East Plant Area has been trending upward in many wells since about 2004. This upward trend in concentrations is not apparent in wells completed west of the 315- 316 well pair.

In the West Plant (Fenceline) Area, phosphorus concentrations in groundwater (Upper Zone and Bedrock) have not changed and remain around 120 mg/L (Figures 3-54 and 3-55). Downgradient in the West Plant Area concentrations of phosphorus decrease to 15 to 35 mg/L and appear to be neither increasing nor decreasing and are similar to concentrations in the Central Plant Area (Figures 3-56 and 3-57). The phosphorus concentration in well 310, completed in the Upper Zone, increased from around 15 mg/L to over 60 mg/L when the nearby multilevel extraction well 415 began operating. The higher concentrations observed in well 334 are similar to those observed in the East Plant Area. Concentrations in the Lower Zone production well SWP-4 decreased in 2008 when multilevel extraction well 412 began pumping.

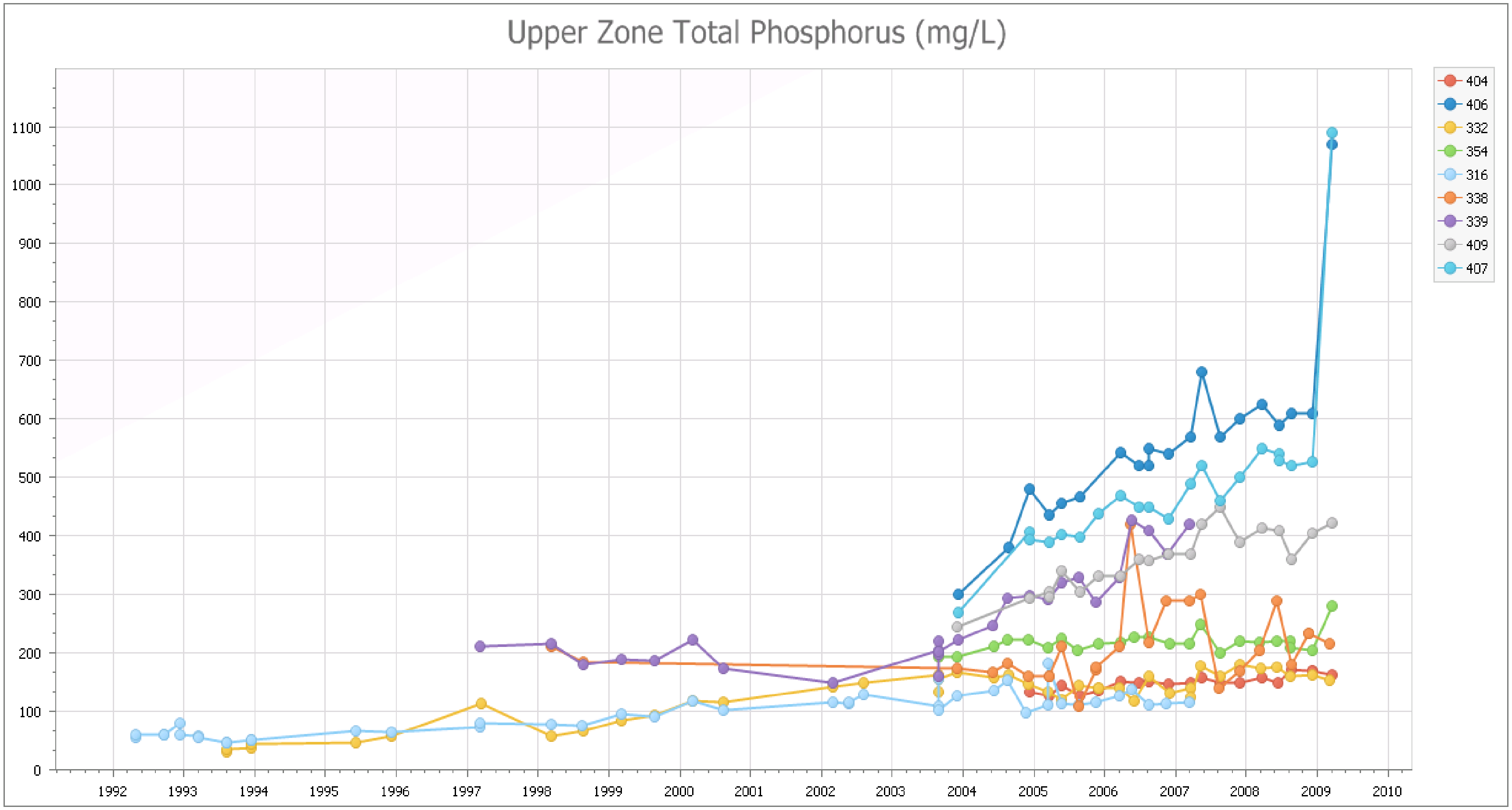


Figure 3-52: Phosphorus trends in Upper Zone wells in the East Plant Area.

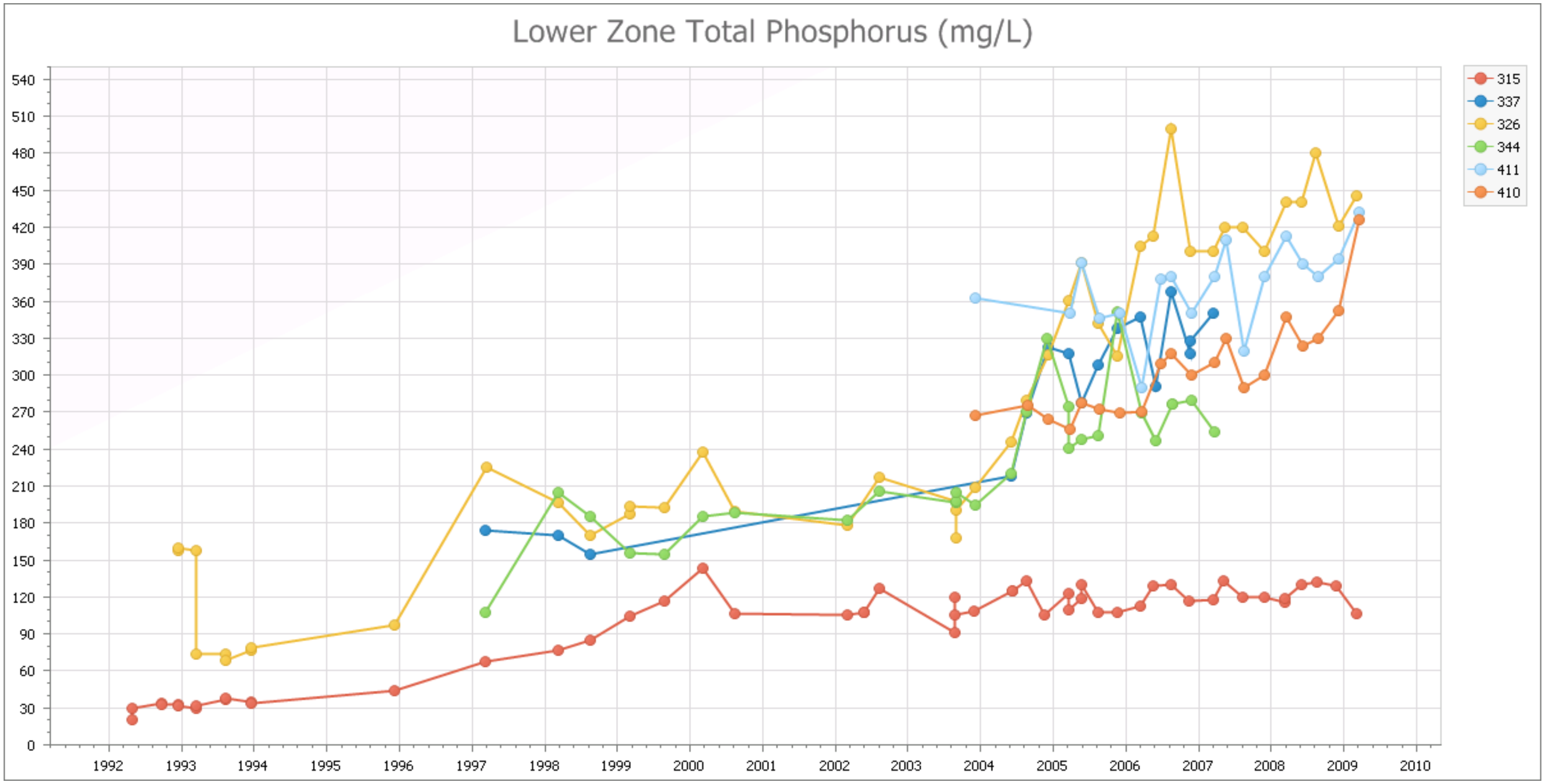


Figure 3-53: Phosphorus trends in Lower Zone wells in the East Plant Area.

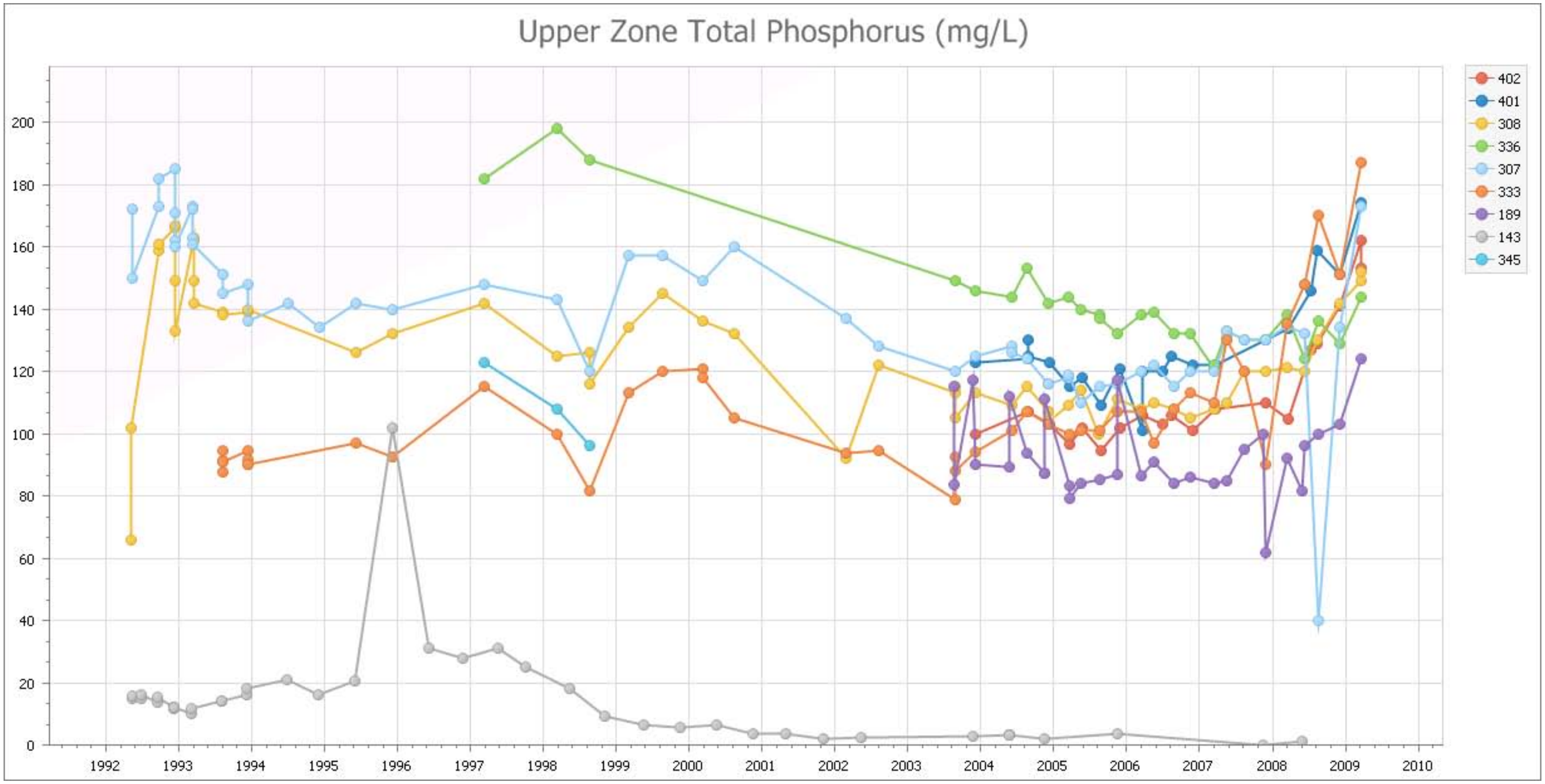


Figure 3-54: Phosphorus trends in Upper Zone wells in the Fenceline Area.

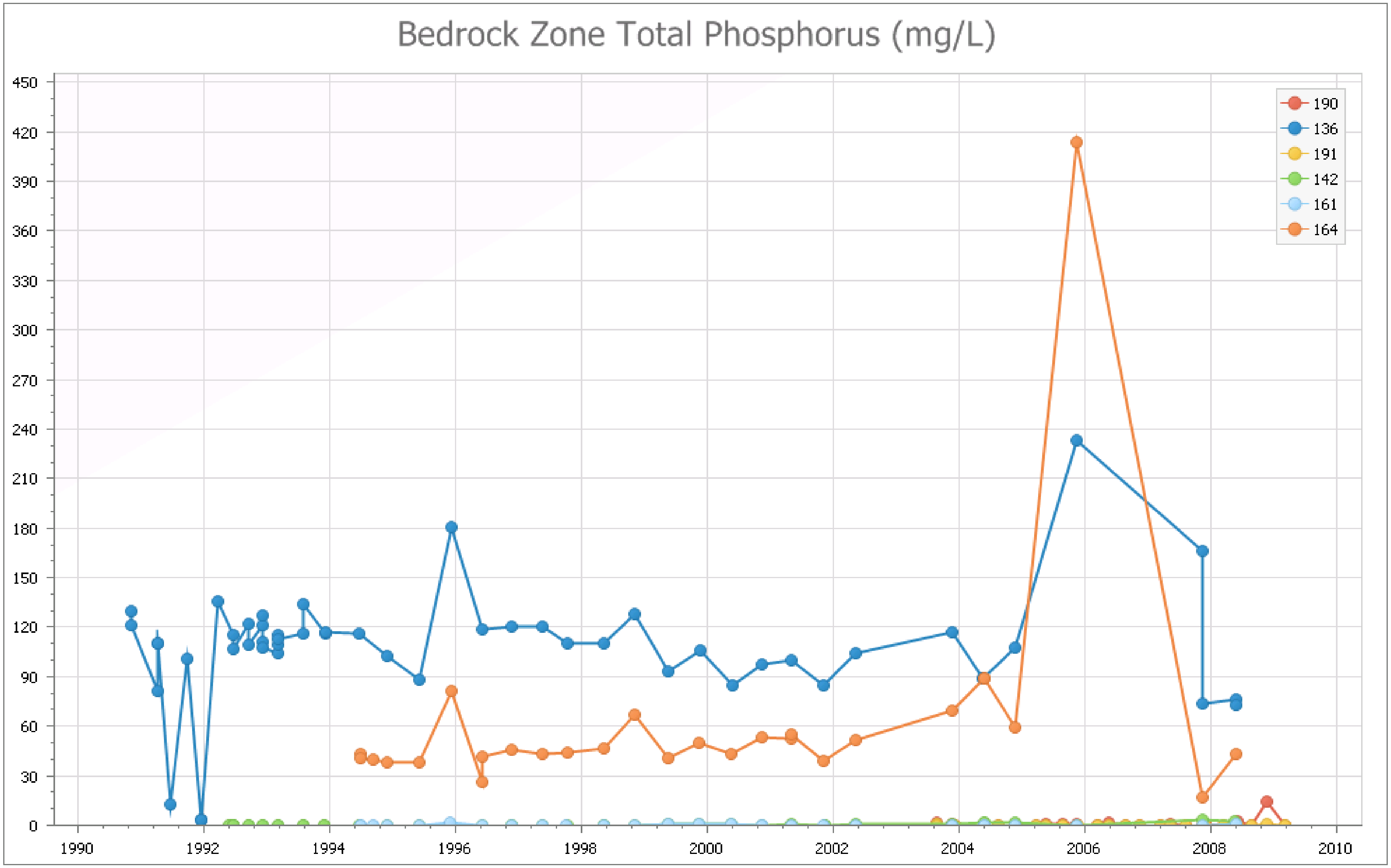


Figure 3-55: Phosphorus trends in Bedrock Zone wells in the Fenceline area.

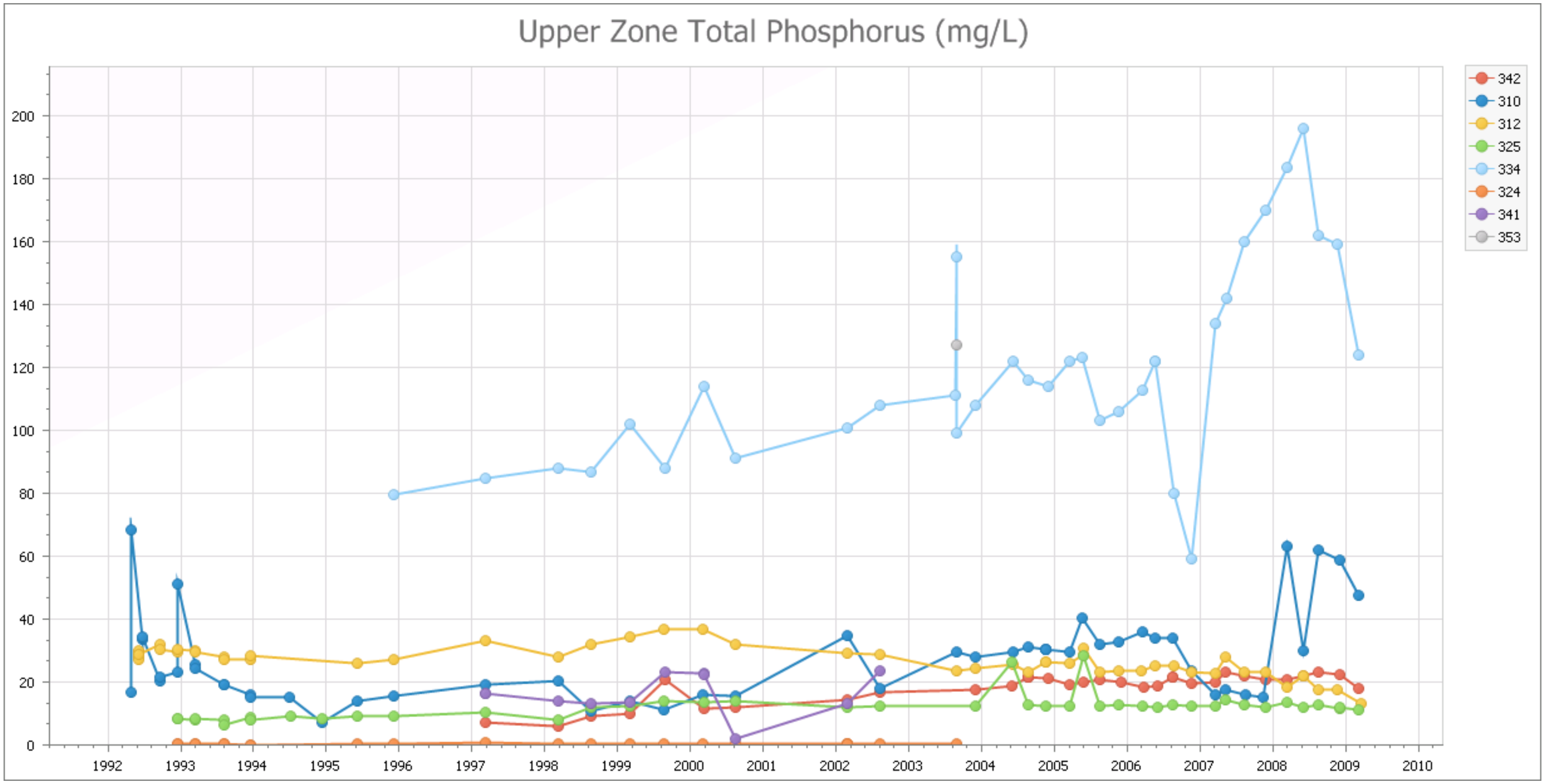


Figure 3-56: Phosphorus trends in Upper Zone wells in the West and Central Plant areas.

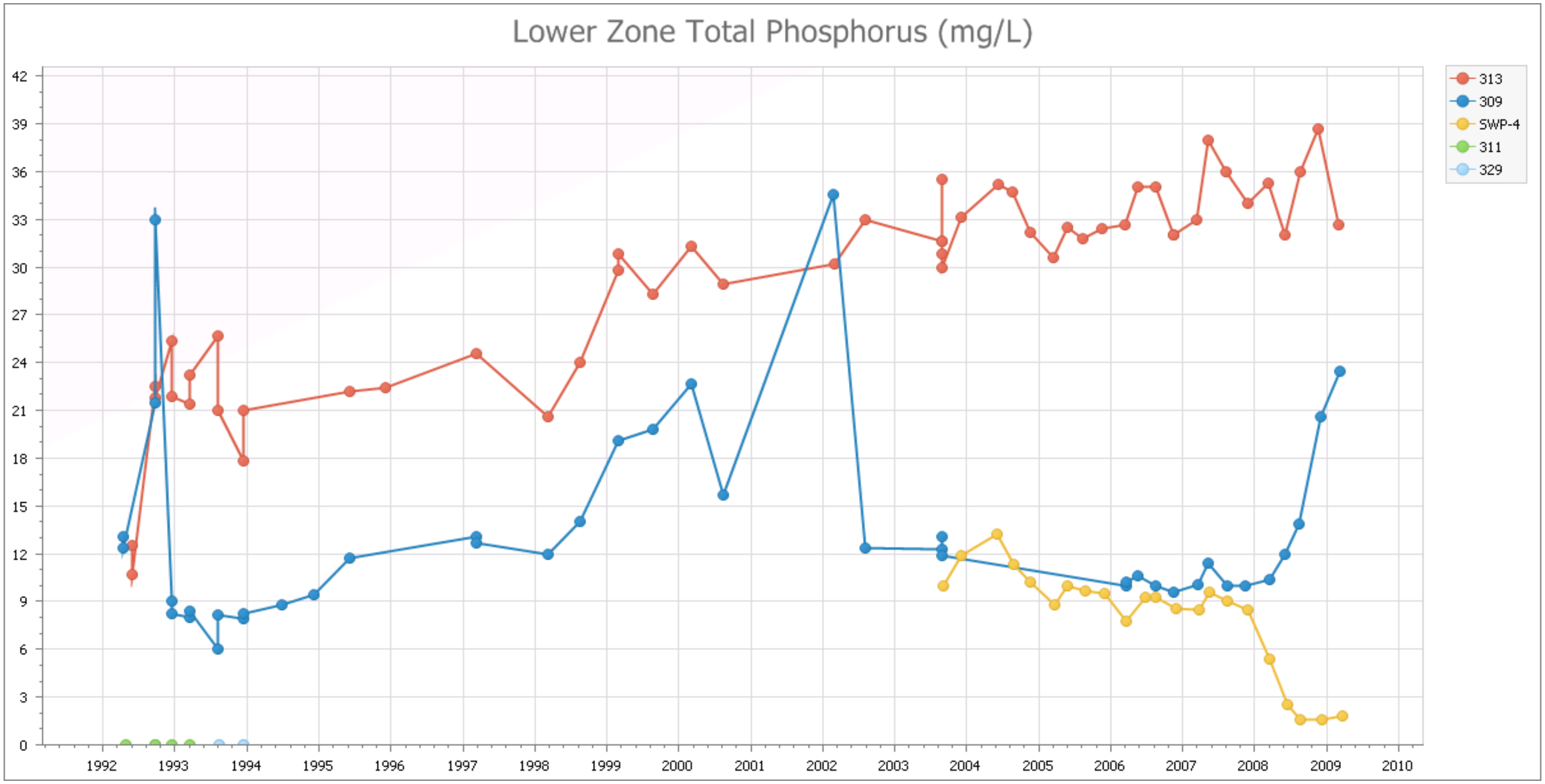


Figure 3-57: Phosphorus trends in Lower Zone wells in the Fenceline and Central Plant Areas.

3.3.4.2.2. Concentration Trends in Groundwater Influenced by the PAP

The PAP Area is located in an area of converging groundwater flow in the Upper Zone (Figure 3-35) with up gradient sources of flow in the southeastern portion of the plant area, near the toe of the gypsum stack, and in the south and southwestern portions of the site. Phosphorus concentrations in this upgradient groundwater flow are elevated as a result of gypsum stack seepage. Well locations in the vicinity are shown in Figure 3-58. Groundwater sample analyses from wells completed down gradient of the PAP Area (wells 320, 335S, 340, 367, 369, and 419) indicate that contributions from sources in the PAP Area have occurred. A subsurface investigation was performed to evaluate the phosphate source characteristics in the PAP Area (Simplot 2009). Some of the important results from this and prior investigations are summarized in the following paragraphs.

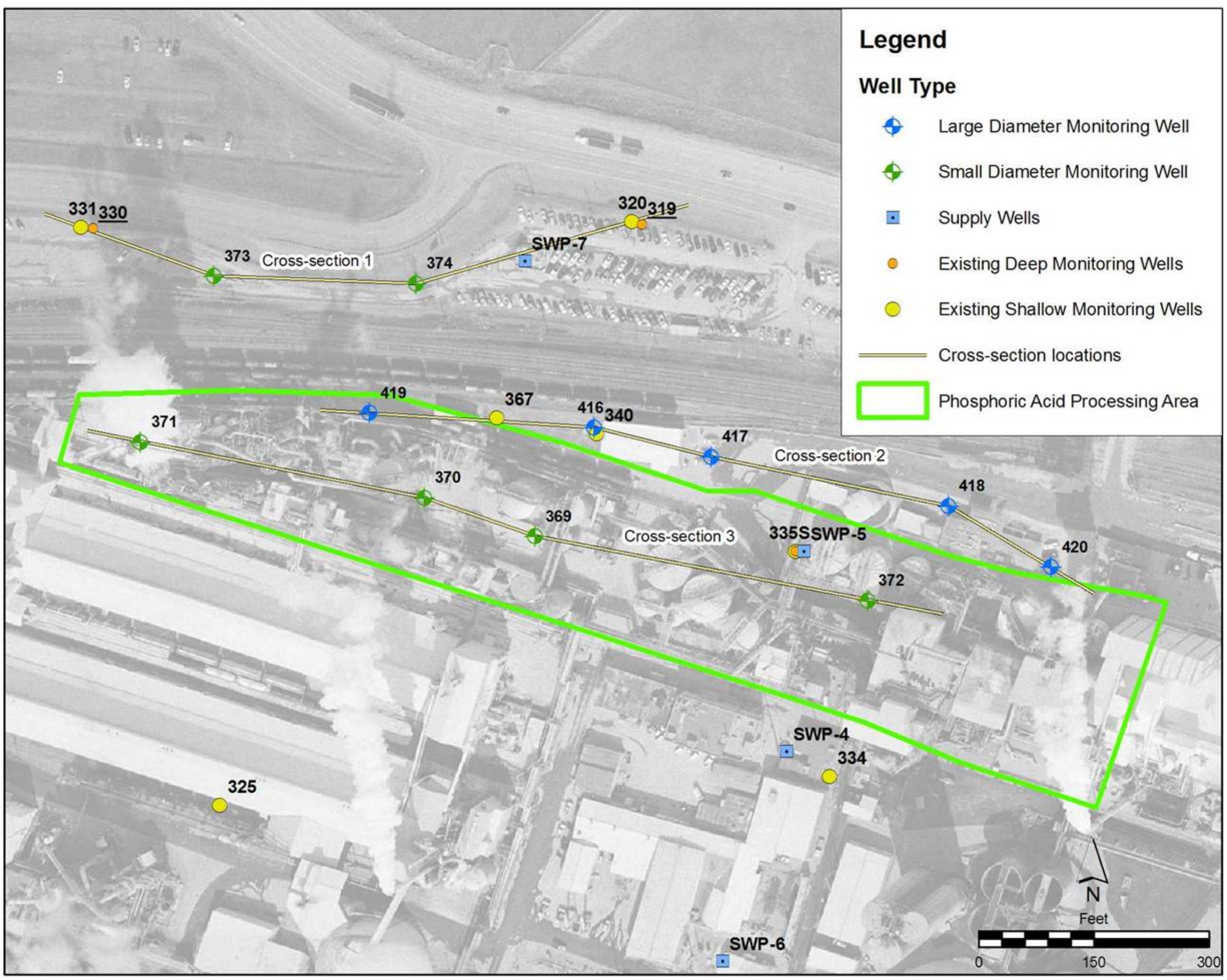


Figure 3-58: Location of monitoring wells, extraction wells and cross section lines in the PAP Area.

Wells 335S, 335D, 414, and 372

Wells 335S and 335D were installed in 1995 as an Upper Zone/Lower Zone well nest. Phosphorus concentrations in the late 1990s were measured as high as 4,000 mg/L, indicating the presence of a PAP source in the vicinity of well 335S. Concentrations at well 335S from 2004 through 2006 were variable, ranging from approximately 300 to 2,000 mg/L (Figure 3-59). However, since 2007 all concentrations have been in the range of 120 to 200 mg/L, consistent with levels associated with gypsum stack effects. The variable concentrations suggest a phosphorus source that is very mobile and transient in nature, such as a release of processing liquids, or the sudden mobilization of a secondary source of phosphorus within the unsaturated zone by an unknown mechanism.

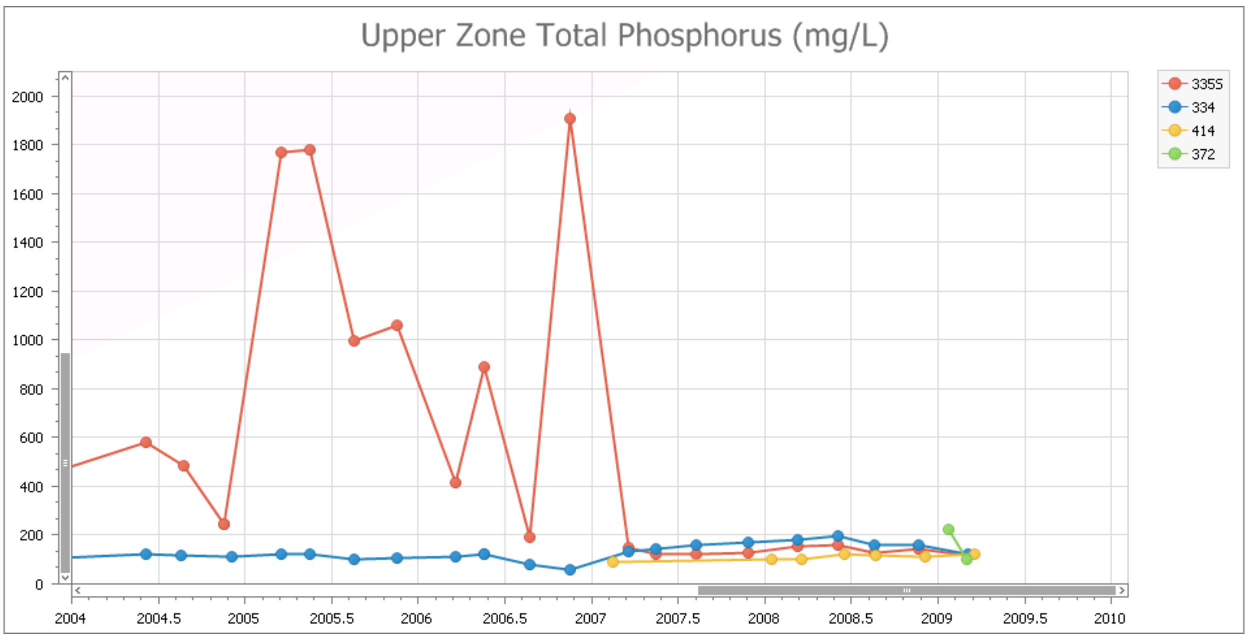


Figure 3-59: Total phosphorus concentrations at well 335S in the Central Plant Area.

The extraction well 414 was installed in January 2007 during the Phase 2 Data Gap Investigation as a test extraction well for the CERCLA groundwater extraction system. Well 414 was located down gradient of well 335S to provide for groundwater extraction near the historical releases observed in this vicinity. Well 414 was brought online in December 2007 and averages approximately 35 gpm. Since initial installation, the phosphorus concentrations in this well have been approximately 100 mg/L (Figure 3-59).

Monitoring well 372 was installed in late 2008 during the PAP subsurface investigation to provide additional characterization of this area. This well also has similar constituent concentrations as well 414 and well 334, which is upgradient of the PAP Area.

Phosphorus concentrations at the Lower Zone monitoring well 335D and in the production well SWP-5 have historically been below 0.5 mg/L (with the exception of a concentration of 4.64 mg/L at well 335D measured in late 2005, Figure 3-60). This indicates that neither the effects of the gypsum stack nor sources in the PAP Area are affecting Lower Zone water quality at these locations.

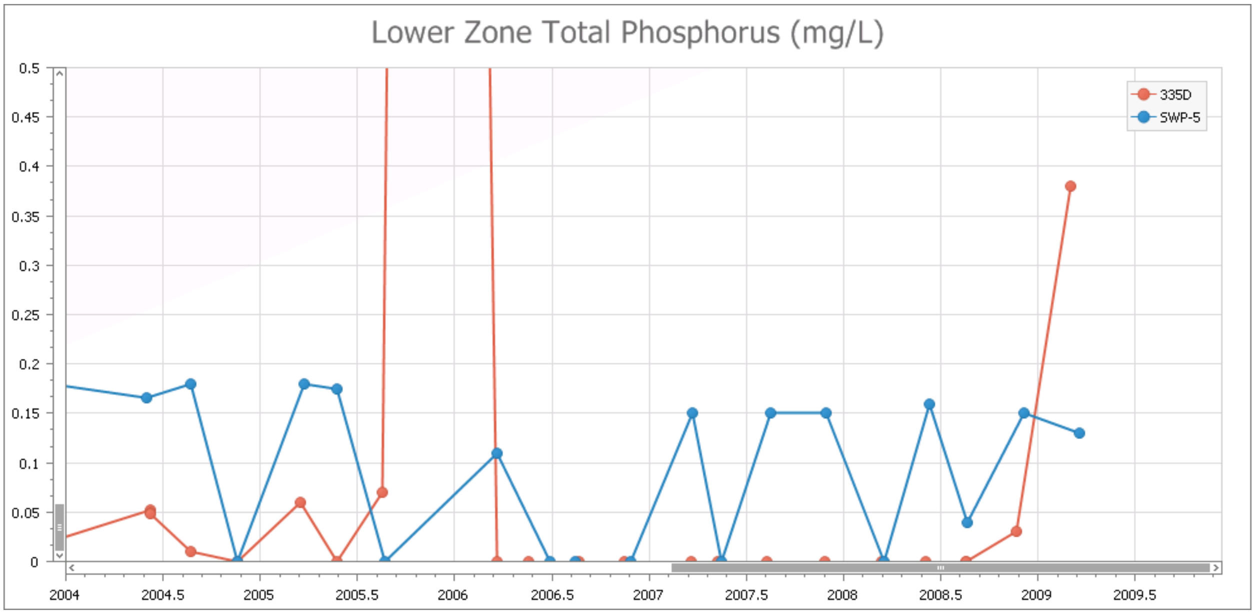


Figure 3-60: Phosphorus concentrations in Lower Zone wells 335D and SWP-5. (Note that a concentration of 4.64 mg/L at well 335D in late 2005 is not shown)

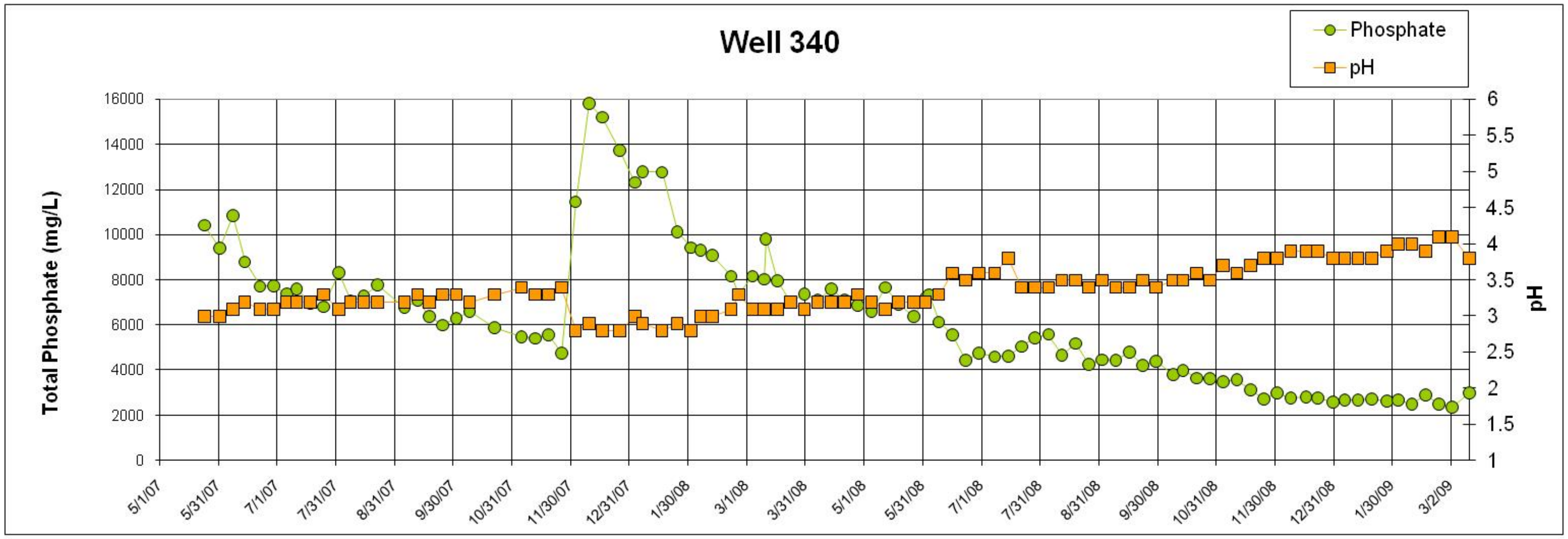
<u>Wells 340, 367 and 416</u>

Well 367 was installed as part of the Phase 2 Data Gap Investigation to evaluate the western extent of potential impacts from PAP Area sources and provide adequate spatial coverage down gradient of potential facility source areas (Figure 3-58). During well development and groundwater sampling, conducted immediately following installation in February 2007, an elevated groundwater temperature was identified in the well (31.6 °C compared to ambient groundwater temperature of 15 to 17 °C). In 2007 sample results indicated elevated concentrations of phosphorus and depressed pH in groundwater samples collected from wells 340 and 367.

As a result of these findings, Simplot initiated weekly groundwater sampling at both these wells and continuous water level and temperature monitoring at well 367. These data have been reported monthly to the EPA and IDEQ. At well 340, phosphorus concentrations were approximately 15,000 mg/L in December 2007 and declined steadily to about 2,000 mg/L by

March 2009 (Figure 3-61). The phosphorus concentrations measured in groundwater at well 367 decreases from over 2,000 mg/L in December 2007 to less than 200 mg/L by March 2009. Concentrations briefly increased in July 2008 at both wells. Groundwater temperature decreased in well 367 in 2007 while remaining stable in well 340 and both wells have shown a similar trend in 2008 with temperatures remaining elevated.

A considerable amount of maintenance work was completed in the PAP Area, specifically in locations suspected of contributing to the elevated concentrations and temperatures in groundwater. Decreases in phosphorus concentration and increases in pH have been observed at both wells, with well 367 returning to concentrations representative of gypsum stack effects (Figure 3-62). The phosphorus concentrations in well 340 remain elevated and pH remains low compared to the levels that would be expected based on the effects of only the gypsum stack. Well 416 was installed approximately 8 feet away from well 340 during the PAP subsurface investigation.



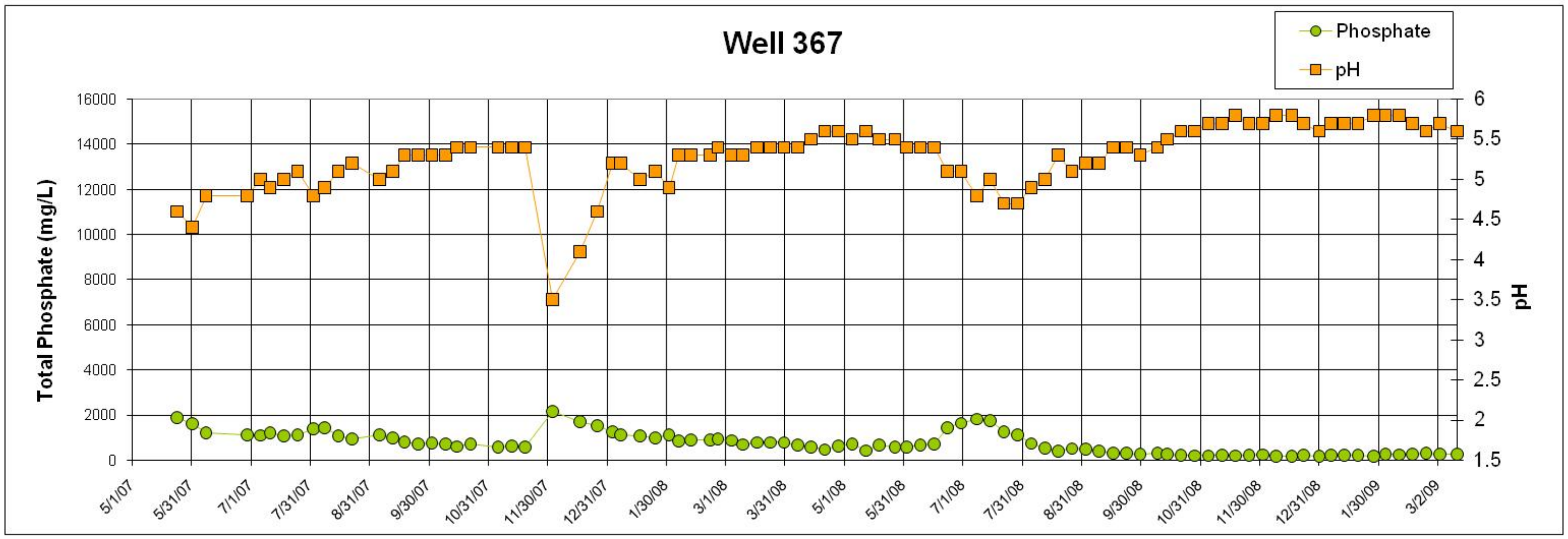


Figure 3-61: Phosphorus concentration and pH in Wells 367 and 340 (Weekly Sampling)

Trace amounts of the chemical tracers used in boiler water in the PAP Area were detected in wells 367 and 340 indicating that the source of elevated groundwater temperature is likely originating from boilers located in the western portion of the PAP Area. Excess boiler water reports to the storm sewer system and eventually to the Land Application System. Leaks in the storm sewer lines in the PAP Area are suspected of causing the elevated groundwater temperatures observed. Extensive repairs were recently made on the storm sewer lines in this area.

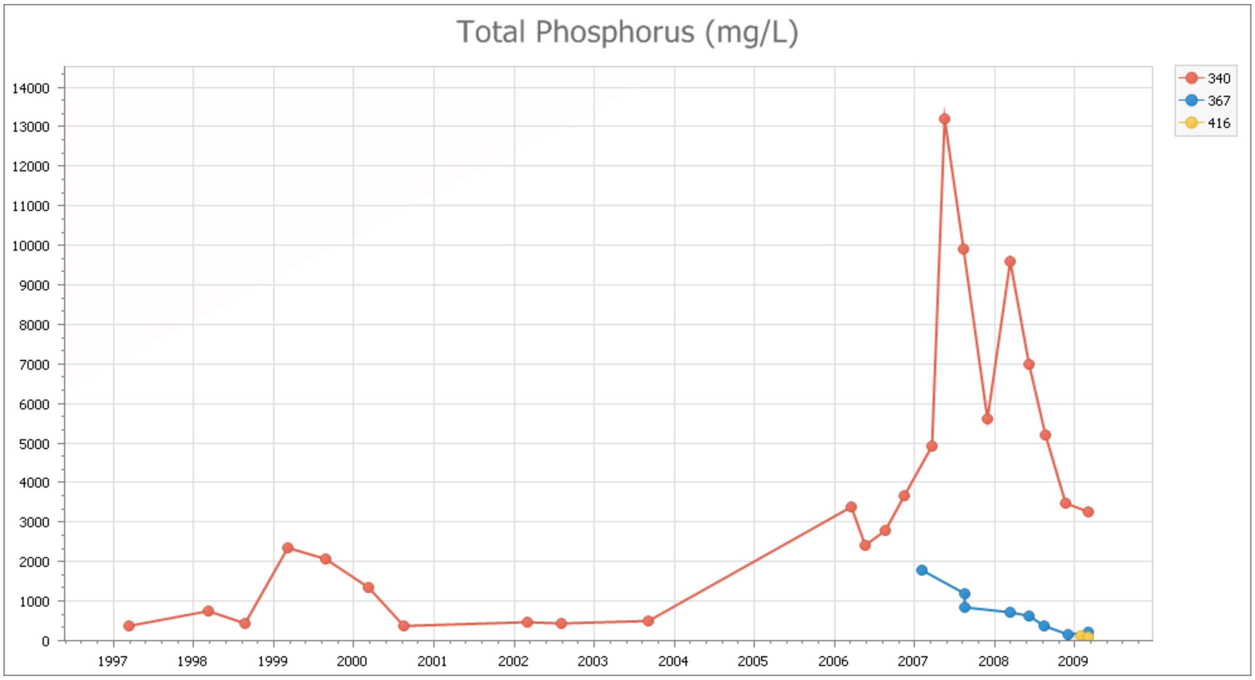


Figure 3-62: Phosphorus concentrations in quarterly groundwater samples from wells 340, 367, and 416 for the period of record.

Wells 419 and 374

Wells 419 and 374 were installed during the PAP subsurface investigation and are located in the western portion of the PAP Area downgradient of the SPA liquid plant. The groundwater chemistry at well 419 indicates that this location is currently being impacted by acidic conditions (Figure 3-63). The well 419 data indicate that the source of acidity is upgradient since the unsaturated zone solids appear unimpacted by the direct migration of acidic process liquids. The unsaturated-zone solids at well 419 contain less than 3,000 mg/Kg phosphorus and the acid neutralizing potential (ANP) is 15 t/Kt; the saturated zone solids at well 419 contain more than 34,000 mg/Kg phosphorus and their ANP has been reduced to zero (Simplot 2009). The groundwater chemistry at well 374, directly downgradient of well 419 (based on January 2009 water level data, see Figure 3-64), has an elevated phosphorus concentration as well as elevated concentrations of many metals observed at well 419 (such as chromium, manganese, vanadium and uranium) indicating that the well is along the groundwater transport pathway from well 419. However, all groundwater concentrations observed at well 374 are attenuated from those observed at well 419 and the pH is higher. The ANP in the saturated zone at well 374 is 55 t/kt and calcite was observed in x-ray diffraction (XRD) analyses.

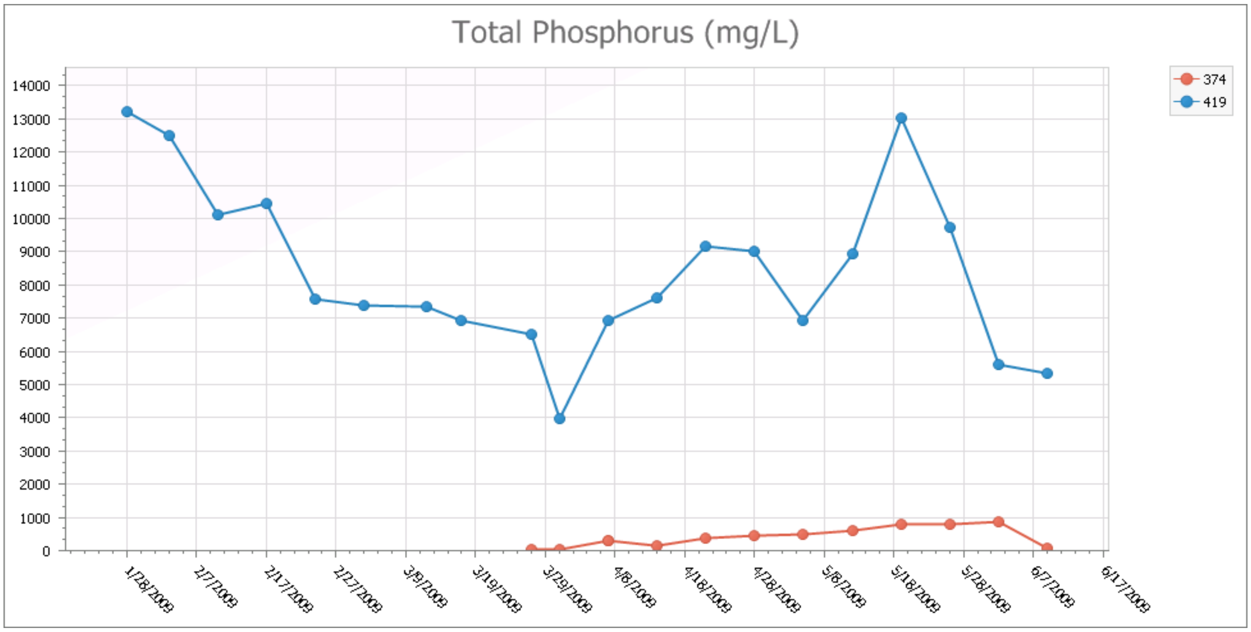


Figure 3-63: Phosphorus concentrations in weekly groundwater samples from wells 419 and 374 to June 9, 2009.

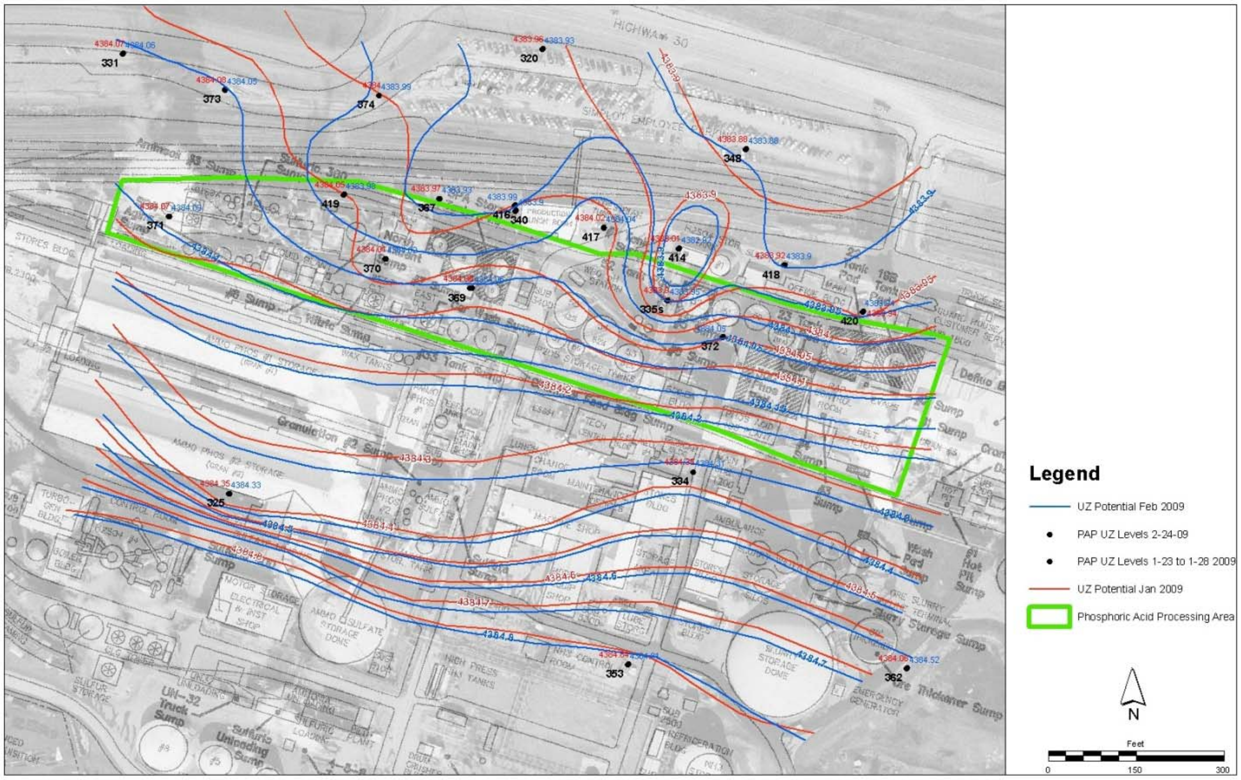


Figure 3-64: Potentiometric surface maps for the Upper Zone in the PAP Area, January and February 2009.

3.3.4.2.3. Concentration Trends in Groundwater Downgradient of the Gypsum Stack and PAP

Phosphorus concentration trends in groundwater in the areas north of both the gypsum stack and the PAP seepage is assessed by the series of monitoring wells that have been installed between the facility and the Portneuf River. As shown in Figures 3-65, and 3-66 the concentration of phosphorus in most wells in this area is below 10 mg/L. Higher concentrations have been observed in the Upper Zone wells 320, 331, and 348, downgradient of the gypsum stack and PAP; and 529A, 529B, and 528B downgradient of the gypsum stack. A higher concentration of phosphorus has also been measured in the Lower Zone well 526. Concentration trends reflect the downgradient effects of source area releases and groundwater extraction. The reduction in magnitude of the concentration values downgradient is the result of dilution and attenuation of phosphorus along the transport pathway (See Figure 3-67).

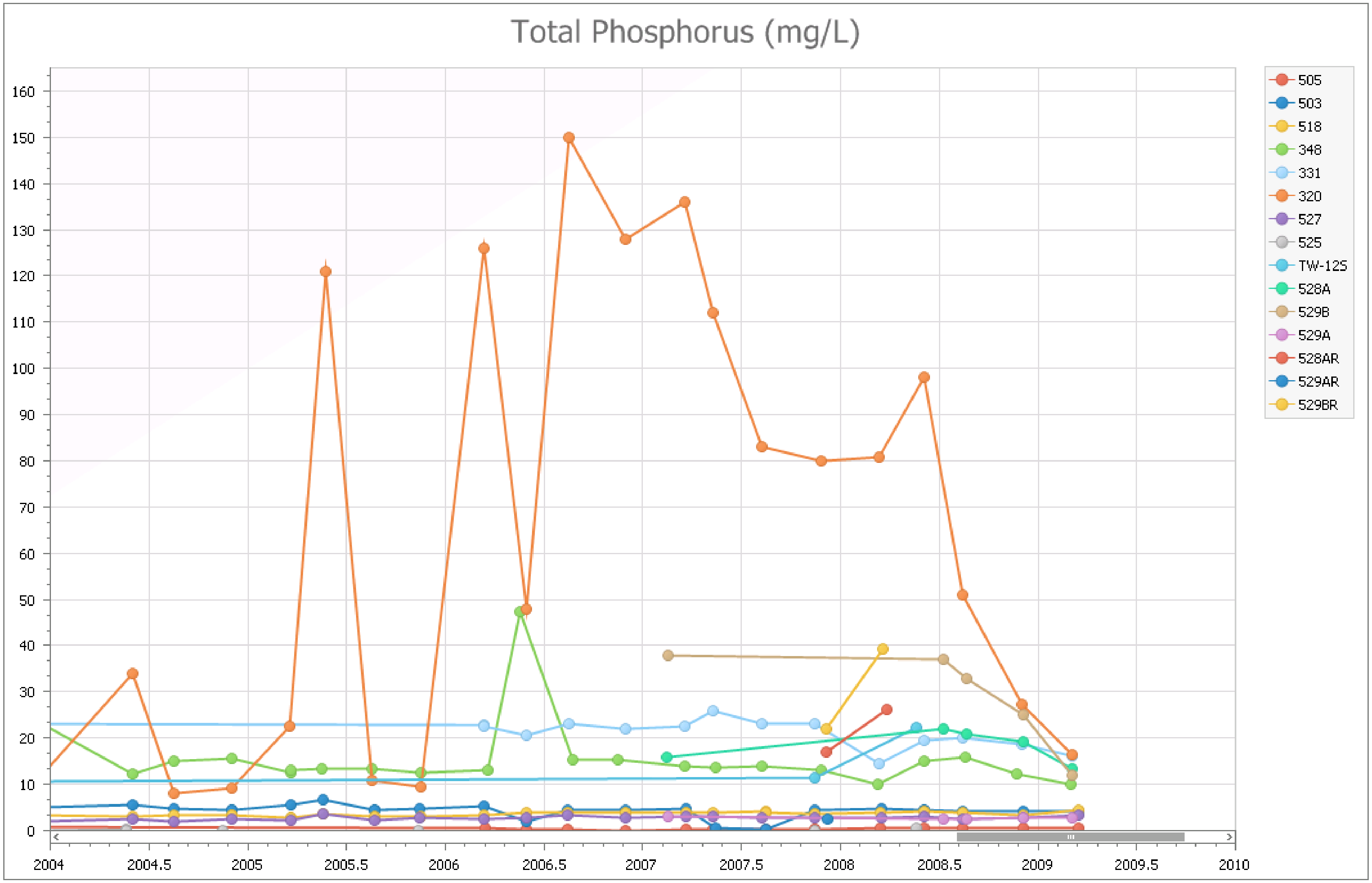


Figure 3-65: Phosphorus concentration trends in Upper Zone wells north of the PAP Area since 2004.

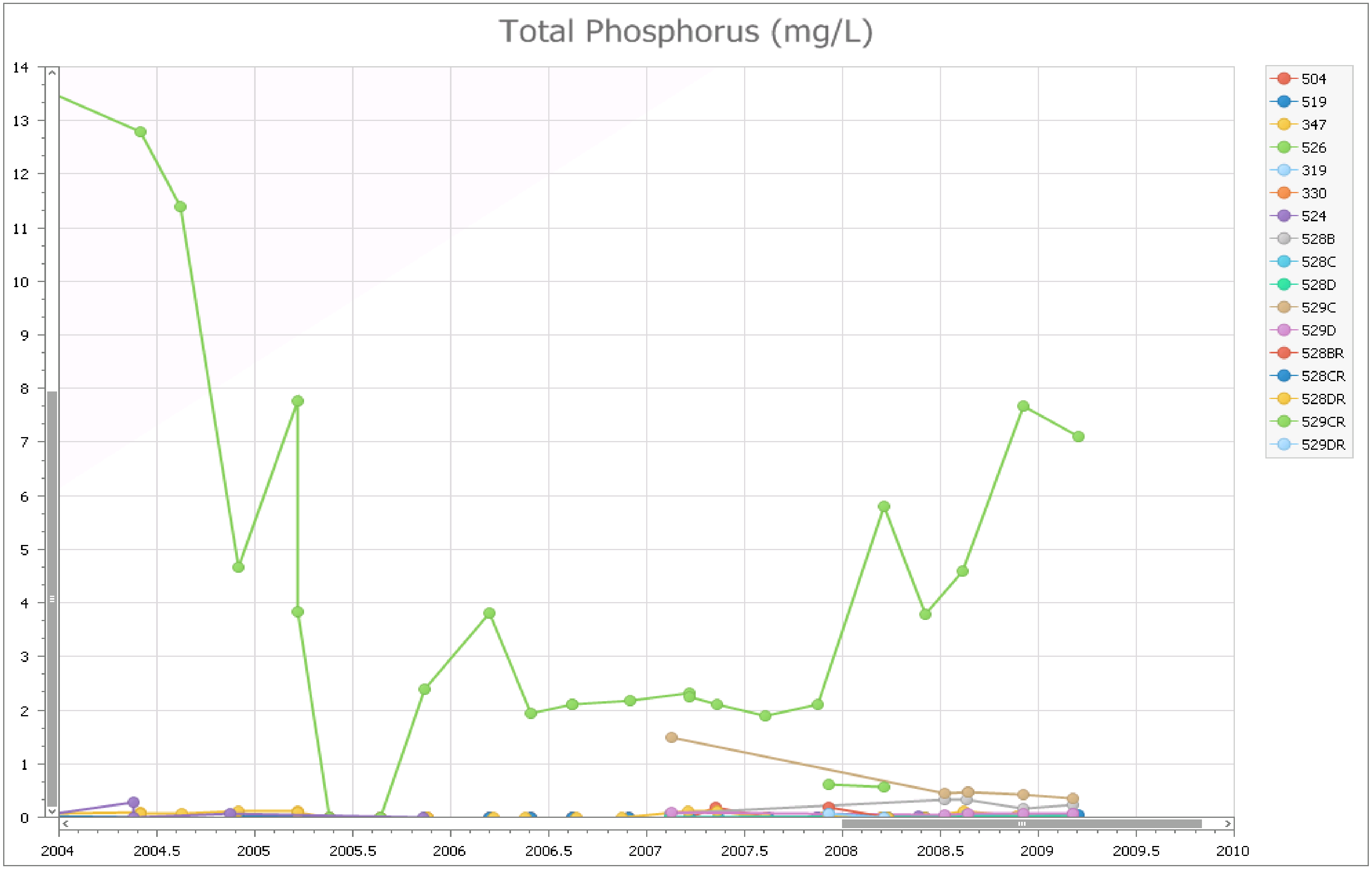


Figure 3-66: Phosphorus concentration trends in Lower Zone wells north of the PAP Area since 2004.

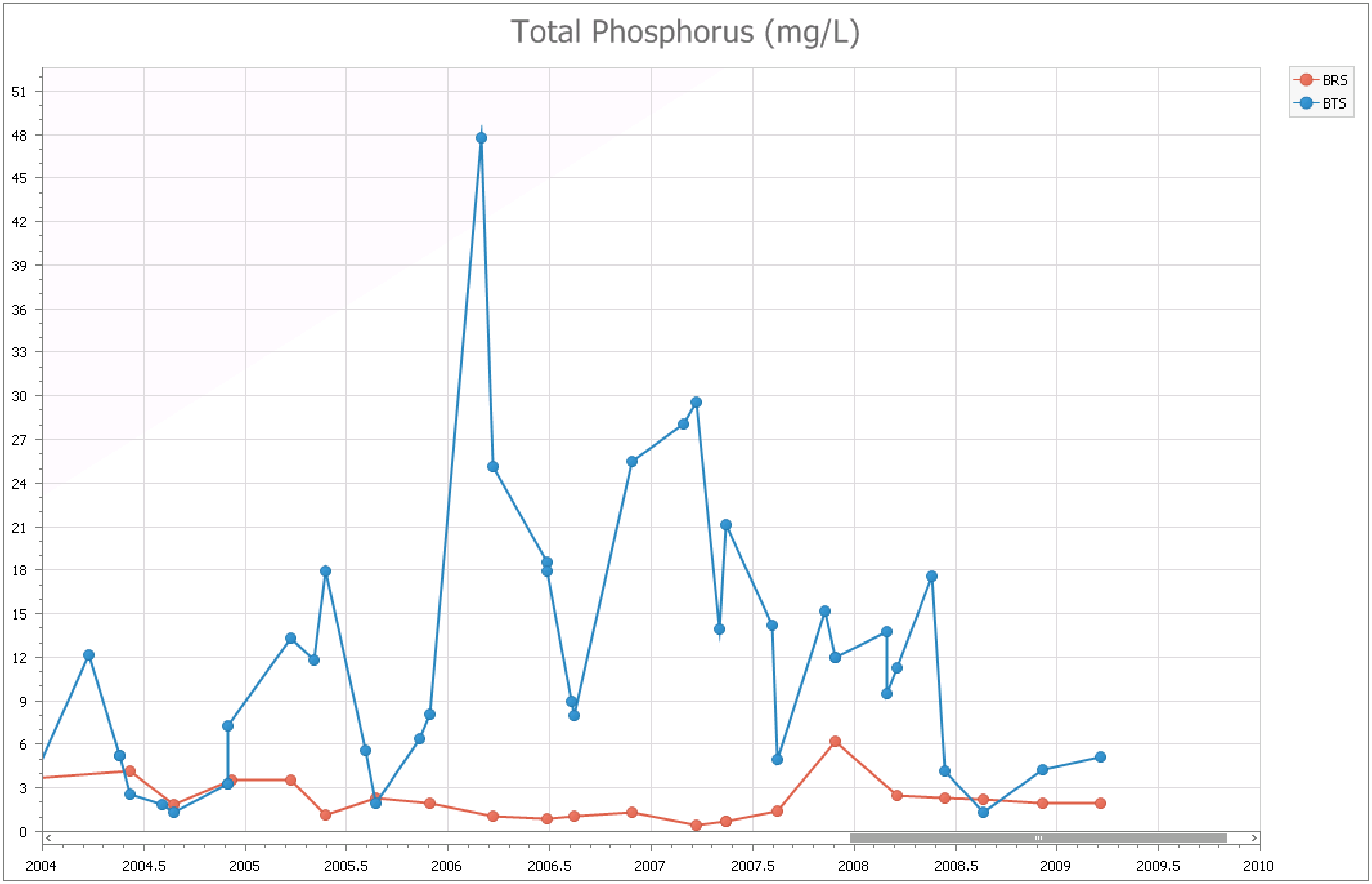


Figure 3-67: Phosphorus concentration trends in springs at the Portneuf River (Batiste Spring = BTS; Spring at Batiste Road = BRS)

3.3.5 Fate and Transport of Site-Derived Constituents

3.3.5.1 Mass Flux of Site-Derived Constituents

An estimate can be made of the mass flux of site-derived constituents in groundwater using the data presented in the previous sections regarding aquifer geometry, aquifer hydraulic properties, groundwater hydraulic gradient, and the distribution of site-derived constituents. In addition, surface water flow and concentration data collected in the Portneuf River by IDEQ to support the TMDL in 2000, 2001, and 2002, can be used to estimate the attenuation of constituents in groundwater along the transport pathway from the facility sources to discharge at the Portneuf River. An explanation of these calculations is provided in the following paragraphs and the calculations are provided in Appendix B.

Overview of The Mass Flux Model

The general mass balance relationship between stack-affected groundwater and surface water in the Portneuf River is shown in Figure 3-68 (Q denotes flow rate, C denotes concentration).

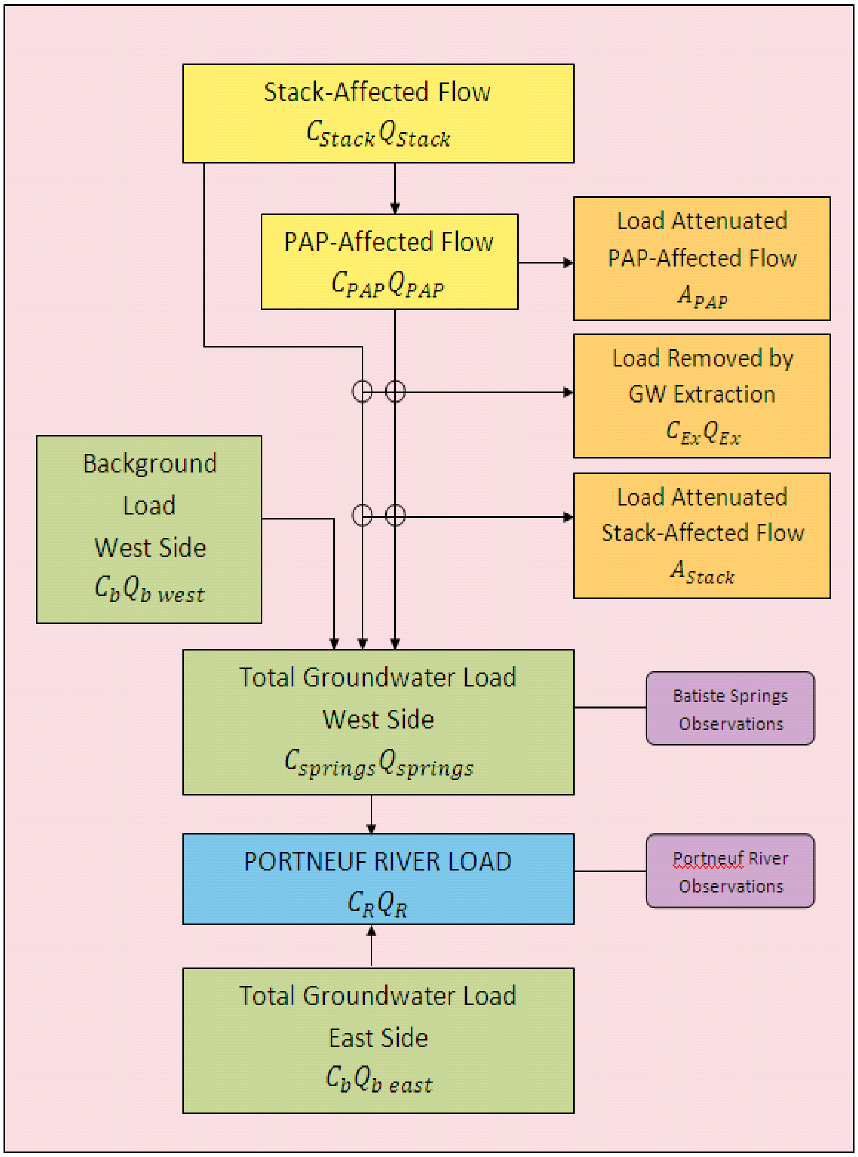


Figure 3-68: Relationship between stack-affected groundwater and the Portneuf River.

The mass flux calculation uses the CSM for groundwater with the following assumptions and concepts:

- Groundwater affected by EMF Site sources discharges to the Portneuf River via surface springs and channel underflow along a relatively short reach (approximately from TMDL stations T-1 to T-3). This is supported both by the IDEQ river sampling data and by groundwater monitoring data which show the plume at the river to extend from the Spring at Batiste Road in the south to Batiste Spring in the north.

- The mass of constituents is conserved, accounting for attenuation, as they travel in groundwater from source areas to the Portneuf River. This is reasonable for the COCs, since they are inorganic and not subject to transformation or destruction by chemical reaction.

- There were no surface water inputs to the Portneuf River during the IDEQ TMDL studies and therefore changes in river flow and water quality were entirely due to discharging groundwater (both from the west side and from the east).

The mass balance is made for groundwater from the extraction area (just downgradient of source areas in the target extraction rates) to the point of discharge to the river. In general, this can be expressed as:

Mass Rate into System = Mass Rate Out of System

where:

Mass Rate into System = Input from Sources + Input from Background

and:

Mass Rate out of System = Mass Rate Removed by Groundwater Extraction + Mass Rate Lost to Attenuation + Mass Rate Discharging at the Portneuf River.

For each case the mass flux is represented by a water flow component (Q) and a constituent concentration component (C), where flow times concentration gives the mass flux (M). The model can be expressed algebraically as follows:

$$\left(C_{gypstack}Q_{gypstack}\right) + (C_bQ_b) + (C_{PAP}Q_{PAP}) = (C_{ex}Q_{ex}) + (M_a) + (C_{river}Q_{river}) \quad [1]$$

where:

$C_{gypstack}$ = Concentration of total phosphorus in water ponded on top of gypsum stack

$Q_{gypstack}$ = Flow rate of seepage through gypsum stack to groundwater

C_b = Concentration of total phosphorus in background groundwater from upgradient

Q_b = Flow of background groundwater from upgradient

C_{PAP} = Average concentration of total phosphrous transported in seepage from the PAP

Q_{PAP} = Average flow of seepage to groundwater from PAP Area.

C_{ex} = Flow-weighted average concentration of total phosphorus in extracted groundwater (including production wells)

Q_{ex} = Extraction flow rate

M_a = Mass of a phosphorus lost due to attenuation as it travels from the source area to the river

Q_{river} = Flow of site groundwater discharging to the river (the mixture of the impacted and background flows)

C_{river} = Flow-weighted average phosphorus concentration in the site groundwater discharging to the river

Site-wide flow is also conserved between the gypsum stack and the discharge point to the Portneuf River. The flow balance is expressed algebraically below:

$$Q_{gypstack} + Q_b + Q_{PAP} = Q_{ex} + Q_{river} \qquad [2]$$

where parameters are described in the same way as equation 1.

Calculation of Model Input Parameters

Flow Rate of Stack-Affected Groundwater (Q_{source})

The rate of flow of stack-affected groundwater from the Simplot Plant Area is calculated as follows:

$$Q_x = K_x i_x A_x \qquad [3]$$

where:

Q_x = Groundwater flow rate for region *x* (L^3/T)

K_x = Average hydraulic conductivity for region *x* (L/T)

i_x = Average hydraulic gradient in region *x* (L/L)

A_x = Cross sectional flow area for region x (L^2)

The calculation involves the following steps:

- Divide stack-affected groundwater flow into contiguous regions and estimate the cross-sectional area of flow of each region (A_x)
- Estimate the average hydraulic gradient that applies to each region (i)
- Estimate the hydraulic properties of each region (K)

To account for all affected groundwater migrating from the site, the Upper and Lower Zones were divided into contiguous regions as shown in Figures 3-69 and 3-70. The regions represent areas that have similar hydraulic and plume characteristics. In the figures, the red lines are drawn along groundwater potential lines in each area and correlate with lines where hydrogeologic cross sections are drawn to determine the cross sectional flow area through which affected groundwater is flowing (A_x in equation 3). The cross section locations correlate with the location of target capture zones. The target capture zones have been characterized to the greatest extent and therefore will provide the lowest degree of uncertainty in the mass flux estimate. A detailed discussion of the rationale for the delineation of the target capture zones is provided in Section 4.1.

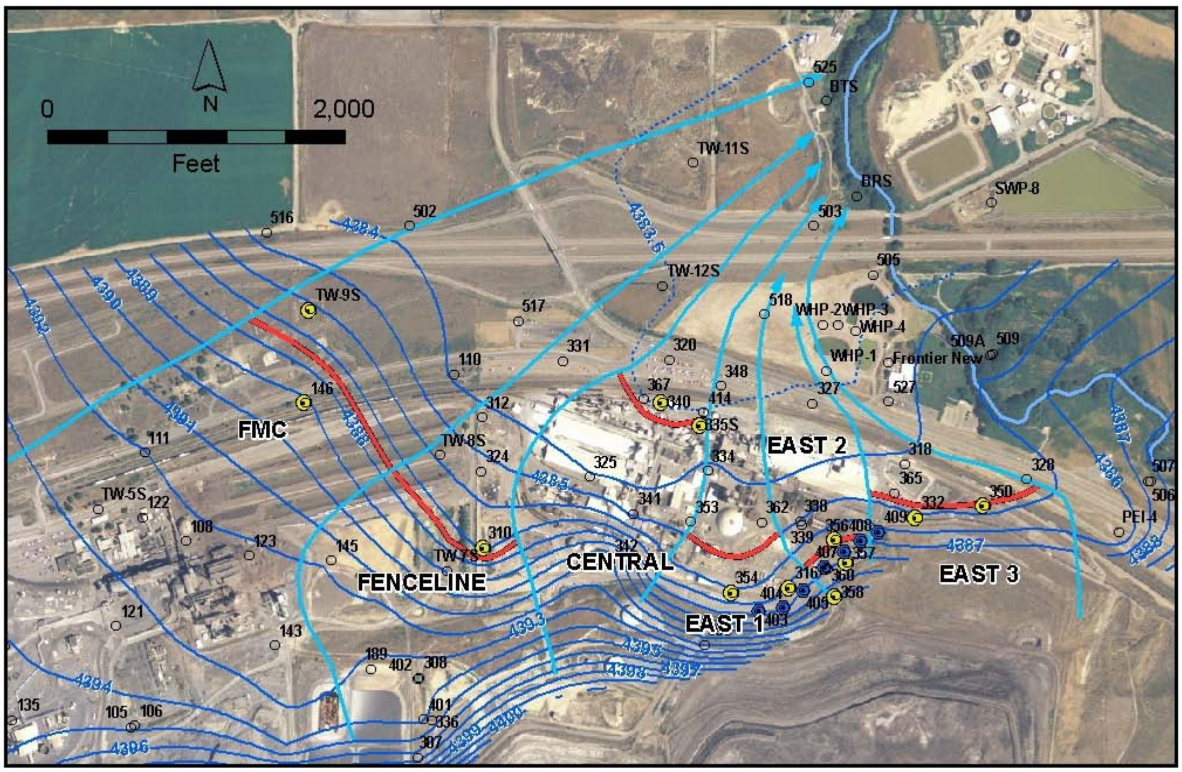


Figure 3-69: Upper Zone flow regions.

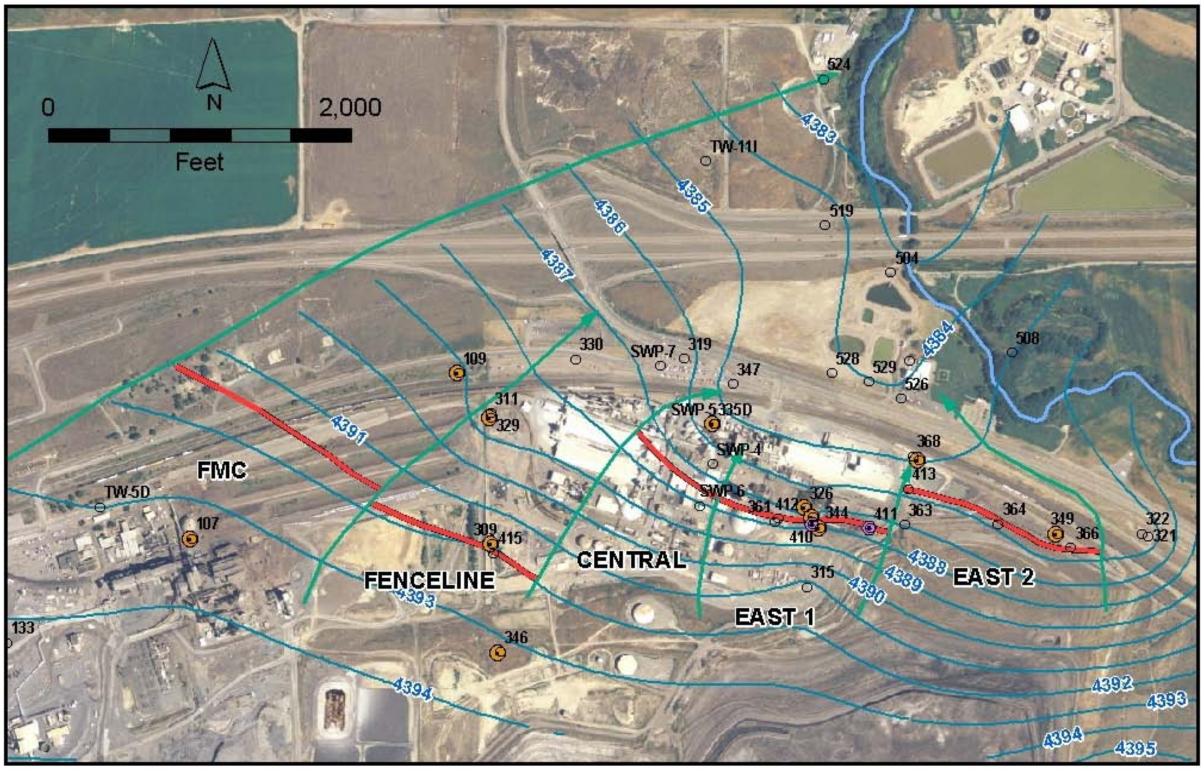


Figure 3-70: Lower Zone flow regions.

The hydrogeologic cross sections shown in Figures 3-12 through 3-20 were drawn along the lines shown in Figures 3-69 and 3-70. Using the cross sections, flow areas were measured graphically. The hydraulic gradient applicable to each area was estimated by measuring the distance (Δl) between groundwater potentiometric contours (Δh). Hydraulic gradients were calculated between potentiometric lines from the steady-state measurement period (August 2003). The hydraulic gradient (i) is calculated:

$$i = (\Delta h) \ / \ (\Delta l) \qquad [4]$$

The hydraulic properties that are appropriate for use in the calculation were estimated by selecting all testing results that are available in the near vicinity of the cross section. Numerous pumping tests have been conducted at the EMF Site since 1992, and as recently as 2008. Statistical analysis was performed on all data collected from slug tests, step tests, and longer pumping tests collected within 200-300 feet of each cross-section (see Appendix B). These data were used to determine the appropriate range of hydraulic conductivity values for each location.

A summary of the calculation of the flow of affected groundwater is included in Table 3-2.

Table 3-2: Summary of affected groundwater flow at the extraction line.

	Width (ft)	Average Thickness (ft)	Area (sf)	Average flow length (ft)	Average Gradient (ft/ft)	Average hydraulic conductivity (ft/day)	Q (cfd)	Q (gpm)
UPPER ZONE								
East Plant Area 1	714	17.9	12,772	398	0.0038	200	9,639	50
East Plant Area 2	494	11.8	5,834	235	0.0085	200	9,930	52
East Plant Area 3	1184	15.6	18,482	392	0.0026	200	9,442	49
Central Plant Area	1227	27.6	33,816	389	0.0026	310	26,948	140
Fenceline Area (FMC and Simplot)	1116	24.3	27,086	135	0.0074	100	20,064	104
FMC Area	1829	39.8	72,712	504	0.0020	250	36,067	187
LOWER ZONE								
East Plant Area 1								
High K zone	1160	77.2	89563	134	0.0075	162	108,278	562
Low K zone	1160	35.5	41213	134	0.0075	50	15,378	80
East Plant Area 2								
High K zone	1406	33.4	46,959	442	0.0034	150	23,932	124
Low K zone	1406	12.3	17,241	442	0.0034	75	4,393	23
Central Plant Area								
High K zone	695	56.3	39,098	236	0.0042	200	33,204	172
Low K zone	695	21.7	15,112	236	0.0042	75	4,813	25
Fenceline Area (FMC and Simplot)								
Entire zone	486	65.2	31,672	251	0.0040	75	9,483	49
							Total Affected Flow	1,618

Constituent Concentrations in Affected Groundwater (C_x)

Constituent concentrations have been evaluated for each of the cross sectional groundwater flow areas using groundwater quality data that have been collected since the RI. In the mass flux calculation, an average concentration value must be used. Average values have been calculated based on the statistical analysis of data from monitoring wells in the vicinity of each section. By plotting long-term trends and averaging data over selected time periods, average concentrations applicable to specific time periods were selected for each section. Time periods of particular interest include the year 2000 when IDEQ began collecting water quality data in the Portneuf River, and current conditions (2008). The results of these analyses are included in Appendix B. The mean concentration values for arsenic, sulfate, and orthophosphate used in the calculation are shown in the summary of the results in Tables 3-3 and 3-4 (columns "Mean P", "Mean SO4" and "Mean As").

Mass Flux of Stack-Affected Groundwater

Mass flux rates are calculated as follows:

$$M_{x1} = Q_x C_{x1} \qquad [5]$$

where:

M_{x1} = Mass flux rate for phosphorus in region x (M/T)

Q_x = Groundwater flow rate for region x (L^3/T)

C_{x1} = Average concentration of phosphorus in region x (M/L^3).

This step is the product of the previous two steps. The results of the calculation are shown in Tables 3-3 and 3-4 (columns "P Load", "SO4 Load", and "As Load").

Table 3-3: Estimated mass flux in source affected groundwater, based on year 2000 chemistry data.

ORTHOPHOPHATE

	Q (gpm)	Mean P (mg/L)	P Load (lb/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	100	27	2.3%
Upper Zone East Plant Area 2				
	52	200	56	4.8%
Upper Zone East Plant Area 3				
	49	50	13	1.1%
Upper Zone Central Plant Area				
Stack	126	100	69	5.8%
340	4	2,000	42	3.6%
335s	10	4,000	211	17.9%
			322	27.4%
Upper Zone West Plant Area				
	104	17	10	0.8%
Upper Zone FMC				
	187	5	5	0.4%
Lower Zone East Plant Area 1				
	642	150	524	44.6%
Lower Zone East Plant Area 2				
	147	150	120	10.2%
Lower Zone Central Plant Area				
	197	85	91	7.8%
Lower Zone West Plant Area				
	49	25	7	0.6%
TOTAL	1,618	133.3	1,176	100.0%
			2,592.3	lb/day

SULFATE

	Q (gpm)	Mean SO_4 (mg/L)	SO4 Load (kg/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	2,700	736	4.8%
Upper Zone East Plant Area 2				
	52	2,700	758	4.9%
Upper Zone East Plant Area 3				
	49	1,900	507	3.3%
Upper Zone Central Plant Area				
Stack	126	1,800	1,238	8.1%
340	4	1,800	38	0.2%
335s	10	2,500	132	0.9%
			1,407	9.2%
Upper Zone West Plant Area				
	104	750	425	2.8%
Upper Zone FMC				
	187	750	765	5.0%
Lower Zone East Plant Area 1				
	562	2,000	6,123	39.9%
Lower Zone East Plant Area 2				
	147	2,000	1,602	10.4%
Lower Zone Central Plant Area				
	197	2,450	2,634	17.1%
Lower Zone West Plant Area				
	49	1,500	402	2.6%
TOTAL	1,538	1,831.7	15,359	100.0%
			33,791	lb/day

ARSENIC

	Q (gpm)	Mean As (mg/L)	As Load (kg/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	0.470	0.128	5.2%
Upper Zone East Plant Area 2				
	52	0.300	0.084	3.4%
Upper Zone East Plant Area 3				
	49	0.150	0.040	1.6%
Upper Zone Central Plant Area				
Stack	126	0.300	0.206	8.4%
340	4	0.300	0.006	0.3%
335s	10	0.300	0.016	0.6%
			0.228	9.3%
Upper Zone West Plant Area				
	104	0.110	0.062	2.5%
Upper Zone FMC				
	187	0.100	0.102	4.2%
Lower Zone East Plant Area 1				
	562	0.400	1.225	50.0%
Lower Zone East Plant Area 2				
	147	0.250	0.200	8.2%
Lower Zone Central Plant Area				
	197	0.310	0.333	13.6%
Lower Zone West Plant Area				
	49	0.180	0.048	2.0%
TOTAL	1,538	0.292	2.451	100.0%
			5.39	lb/day

Table 3-4: Estimated mass flux in source affected groundwater, based on year 2008 chemistry data.

ORTHOPHOPHATE

	Q (gpm)	Mean P (mg/L)	P Load (kg/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	276	75	4.1%
Upper Zone East Plant Area 2				
	52	430	121	6.6%
Upper Zone East Plant Area 3				
	49	300	80	4.4%
Upper Zone Central Plant Area				
Stack	126	96	66	3.6%
340	2	2,991	32	1.7%
419	12	7,338	464	25.3%
			562	30.6%
Upper Zone West Plant Area				
	104	62	35	1.9%
Upper Zone FMC				
	187	3	3	0.2%
Lower Zone East Plant Area 1				
	642	210	734	40.0%
Lower Zone East Plant Area 2				
	147	166	133	7.2%
Lower Zone Central Plant Area				
	189	85	88	4.8%
Lower Zone Fenceline Plant Area				
	49	20	5	0.3%
TOTAL	1,610	209.2	1,836	100.0%
			4,039.0	lb/day

SULFATE

	Q (gpm)	Mean SO4 (mg/L)	SO4 Load (kg/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	2,707	738	4.3%
Upper Zone East Plant Area 2				
	52	2,990	840	4.9%
Upper Zone East Plant Area 3				
	49	1,985	530	3.1%
Upper Zone Central Plant Area				
Stack	126	1,465	1,008	5.9%
340	2	1,964	21	0.1%
419	12	1,530	97	0.6%
			1,125	6.6%
Upper Zone West Plant Area				
	104	1,595	905	5.3%
Upper Zone FMC				
	187	286	292	1.7%
Lower Zone East Plant Area 1				
	642	2,334	8,160	47.8%
Lower Zone East Plant Area 2				
	147	1,966	1,575	9.2%
Lower Zone Central Plant Area				
	189	2,500	2,574	15.1%
Lower Zone Fenceline Plant Area				
	49	1,200	322	1.9%
TOTAL	1,610	1,944.0	17,059	100.0%
			37,531	lb/day

ARSENIC

	Q (gpm)	Mean As (mg/L)	As Load (kg/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	0.474	0.129	5.4%
Upper Zone East Plant Area 2				
	52	0.309	0.087	3.6%
Upper Zone East Plant Area 3				
	49	0.250	0.067	2.8%
Upper Zone Central Plant Area				
Stack	126	0.219	0.150	6.3%
340	2	0.882	0.009	0.4%
419	12	0.311	0.020	0.8%
			0.179	7.5%
Upper Zone West Plant Area				
	104	0.250	0.142	5.9%
Upper Zone FMC				
	187	0.084	0.086	3.6%
Lower Zone East Plant Area 1				
	642	0.325	1.136	47.5%
Lower Zone East Plant Area 2				
	147	0.209	0.167	7.0%
Lower Zone Central Plant Area				
	189	0.350	0.360	15.1%
Lower Zone Fenceline Plant Area				
	49	0.150	0.040	1.7%
TOTAL	1,610	0.273	2.394	100.0%
			5.27	lb/day

Mass Removal by SWP-4

The mass of stack-affected groundwater constituents removed by the water supply well SWP-4 must be accounted for in the mass flux calculation. This mass is simply the concentration of the constituent multiplied by the flow rate. Flow rate is measured continuously in the well and concentrations are measured in samples collected quarterly. A simple mass balance calculation can also be used to estimate the quantity of stack affected groundwater flow that is being intercepted by the well, if a plume constituent concentration is assumed. These calculations are detailed in Appendix B.

Flow of Unaffected Groundwater Discharging to the Portneuf River (Q_b)

As previously described, IDEQ performed investigations in the Portneuf River in support of the TMDL that provide an estimate of the mass loading (flow and concentration) of constituents in the river near the EMF Site (IDEQ 2004). The data show that constituents from the EMF Site groundwater discharge to the river over a relatively short reach (approximately from sampling station T1 to station T3; Figure 3-71) and only from the west side of the river. This is consistent with groundwater data that show impacts between Batiste Spring to the north and the Spring at Batiste Road to the south. Both the river flow rate and concentrations of certain constituents increase in this reach.

The IDEQ data provide an important means for checking the groundwater mass flux calculation, calculating attenuation prior to discharge to the river, and estimating the groundwater flow contributions from the east and west sides of the Portneuf River. Unaffected groundwater entering the river on the west side mixes with groundwater affected by the EMF Site facilities prior to discharge to the river. Understanding this mixing is necessary to predict the effects of groundwater extraction in the Simplot Plant Area on groundwater concentrations at the point of discharge. The method used for estimating this groundwater inflow rate is described in the following paragraphs.

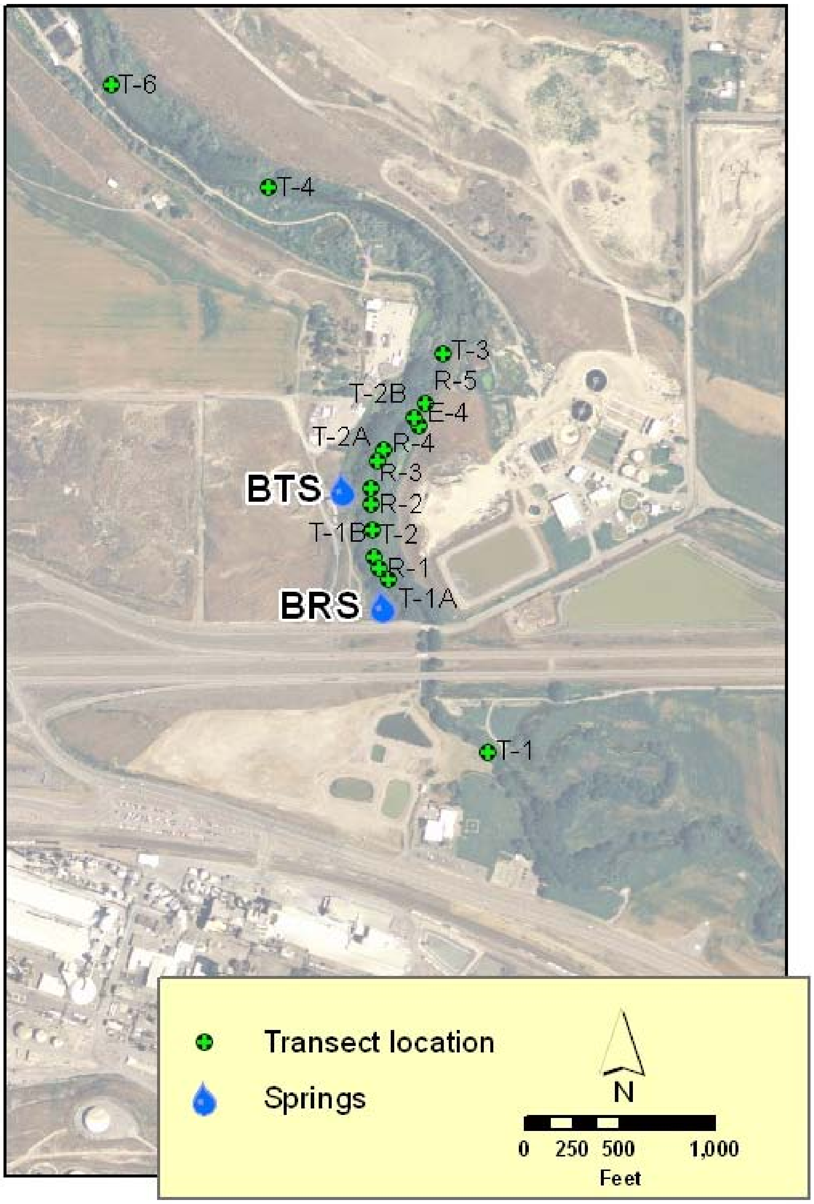


Figure 3-71: Location of IDEQ's Portneuf River transects.

Since surface water inflow in the T-1 to T-3 reach is negligible, the increase in the river is equal to the discharge of groundwater and the mass load change measured in the river is equal to the mass load input from groundwater. These relationships are represented as follows:

$$\Delta Q_r = Q_{r,T3} - Q_{r,T1} \quad [6]$$

and

$$\Delta(C_r Q_r) = C_{r,T3} Q_{r,T3} - C_{r,T1} Q_{r,T1} \quad [7]$$

where:

Q_r = Flow of groundwater discharging to the river between stations T1 and T3

C_r = Average constituent concentration in groundwater discharging to the river (from both sides)

$Q_{r,\,T1}$ = Measured flow in the river at station T1

$Q_{r,T3}$ = Measured flow in the river at station T3

$C_{r,\,T1}$ = Measured constituent concentration in the river at station T1

$C_{r,\,T3}$ = Measured constituent concentration in the river at station T3

Further, the groundwater input to the river is comprised of two distinct sources; the west side (impacted by EMF Site sources) and the east side (background), such that

$$\Delta Q_r = Q_{b,\,east} + Q_{springs} \qquad [8]$$

and

$$\Delta(Q_r C_r) = Q_{b,\,east} C_{b,\,east} + Q_{springs} C_{springs} \qquad [9]$$

Solving for $Q_{springs}$ yields

$$Q_{springs} = \left(\frac{\Delta(Q_r C_r) - Q_r C_b}{C_{springs} - C_b} \right) \qquad [10]$$

The groundwater on the east side of the river is not impacted by site sources and is assumed to be at unaffected levels, thus C_b is known for each constituent. Concentrations in the springs on the west side of the river (Batiste Spring and the Spring at Batiste Road) provide a measurement of $C_{springs}$. The Spring at Batiste Road TMDL data were used in the evaluation. Using these inputs, it is therefore possible to generate an estimate of the relative inflows of groundwater from each side of the river.

There are four sets of data from the three TMDL investigations to support this calculation; orthophosphate from 2000, 2001 and 2002 and sulfate from 2002. The calculation yields the following results in terms of percentage of total groundwater that comes from the west (site) side (see Appendix B; Table 1):

- September 2000 – 66% (based on orthophosphate as total phosphorus)
- August 2001 – 59% (based on orthophosphate as total phosphorus)

- September 2002 - 49% (based on orthophosphate as total phosphorus) and 32% (based on sulfate)

As shown, the estimate of discharge from the west (site) side of the river ranges from 32% to 66% of the total discharge. For the purposes of the calculation presented in this document it is assumed that 50% of groundwater discharges from each side of the river.

Concentrations in Unaffected Groundwater Discharging to the Portneuf River (C_b)

Concentration of unaffected groundwater, $C_{b,}$ was estimated using historical results from monitoring wells 502, 506, 507, 509, 511, 512, 513, 514, 515, and 516. These monitoring locations (Appendix B) were selected based on the following:

- The range of the historical concentrations indicate no impacts from Site-affected groundwater
- Potentiometric surfaces indicate these wells fall outside the influence of stack-affected groundwater and FMC-affected groundwater.

Probability plots and summary statistics for arsenic, sulfate, and orthophosphate concentrations for the selected wells are included in Appendix B. The 95% upper confidence limit on the mean for arsenic is calculated as 0.0039 mg/L, for sulfate it is 57 mg/L and for orthophosphate it is 0.08 mg/L.

Calculated Attenuation in Groundwater Prior to Discharge

The mass of constituents that are lost due to attenuation mechanisms in groundwater between the areas of the EMF Site where mass flux in groundwater due to sources areas was evaluated and the Portneuf River can be estimated from Equation [1]. The attenuated mass is simply the difference in the mass estimated to be leaving the EMF Site in groundwater and the mass load measured in the Portneuf River between stations T-1 and T-3. Attenuation can only be assessed for the constituents whose concentrations were measured in both regimes, namely sulfate and orthophosphate. Arsenic concentrations in the Portneuf River were not measured during the IDEQ study.

Attenuation calculations are provided in Appendix B. Based on the mass flux calculation; about 20% of the sulfate load in groundwater is lost prior to discharge at the river and 39% of the orthophosphate load is lost. The results of the PAP Area subsurface investigation (Section 5 of Technical Report No. 1 [Simplot 2009]) indicate that the attenuation mechanism for releases of acidic process liquids in the PAP Area are different than along the migration pathway in the more neutral pH groundwater aquifer across the site. The attenuation of acidic process liquids in groundwater (saturated zone) appears to be at least 90%.

Calculated Groundwater Discharge Concentrations

Average concentrations of constituents in groundwater just prior to discharge can be calculated using the mass flux model. The calculation is provided for year 2000 and 2008 conditions in Appendix B. A summary of the results based on year 2000 conditions is provided in Table 3-5. For comparitive purposes the predictions based on the year 2000 data are shown along with concentrations observed at Batiste Springs in Figure 3-72.

Table 3-5: Summary of the mass flux calculation used to calculate average groundwater concentrations near the discharge point at the Portneuf River based on conditions observed in 2000.

Parameter	**Groundwater Flow**						
Q_{Stack}	Flow of stack-affected groundwater in Plant Area	3.3	cfs				
Q_{PAP}	Flow of PAP-affected groundwater (low pH)	0.3	cfs				
Q_{Ex}	Flow stack affected groundwater from SWP-4	0.4	cfs				
Q_b	Flow of unaffected groundwater discharging to west side of river	30.5	cfs				
$Q_{springs}$	Total groundwater flow discharging to west side of river	33.9	cfs				
	Mass Flux	**Arsenic**		**Sulfate**		**Orthophosphate**	
$C_{Stack} * Q_{Stack}$	Mass in groundwater down gradient of stack sources	2.429	kg/day	15,190	kg/day	923	kg/day
$C_{PAP} * Q_{PAP}$	Mass contributed from low pH sources in PAP	0.022	kg/day	170	kg/day	253	kg/day
A_{PAP}	Attenuation of uncaptured PAP flow	-	kg/day	153	kg/day	228	kg/day
$C_{ex} * Q_{ex}$	Mass Removed by SWP-4	0.313	kg/day	2,473	kg/day	86	kg/day
A_{Stack}	Attenuation of Stack flow	-	kg/day	2,604	kg/day	334	kg/day
$C_b * Q_b$	Mass in unaffected groundwater	0.291	kg/day	4,252	kg/day	6.0	kg/day
	Net mass discharging to river from west side groundwater	2.429	kg/day	14,382	kg/day	535	kg/day
	Concentrations at Discharge						
C_b	Local groundwater concentration	0.0039	mg/L	57	mg/L	0.08	mg/L
$C_{springs}$	Estimated average concentration in groundwater at discharge	0.0293	mg/L	173	mg/L	6.44	mg/L

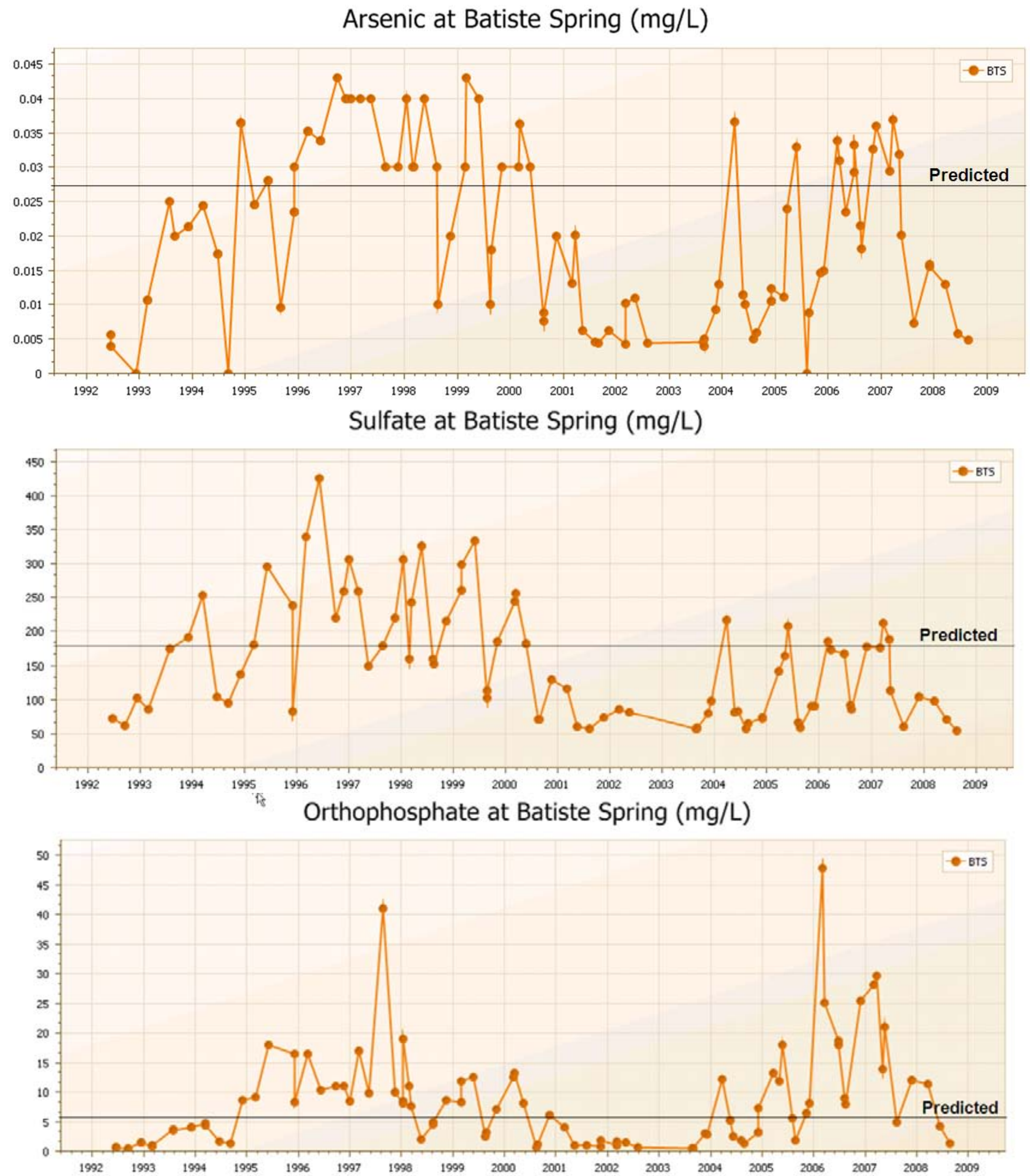


Figure 3-72: Predicted groundwater discharge concentrations based on year 2000 data compared to concentrations measured over time at Batiste Spring.

3.3.5.2 Attenuation Mechanisms

An evaluation of attenuation mechanisms for sulfate and arsenic was performed using groundwater chemistry data from a flow path between test extraction well 406 and monitoring well 339 (Figure 3-73). This flow path was selected to evaluate potential in-situ attenuation mechanisms because it appears that there is no influence from other, chemically distinct waters on groundwater chemistry between these two locations. Any chemical reactions taking place along this flow path should be discernable by direct comparison of the well 406 and well 339 water chemistries.

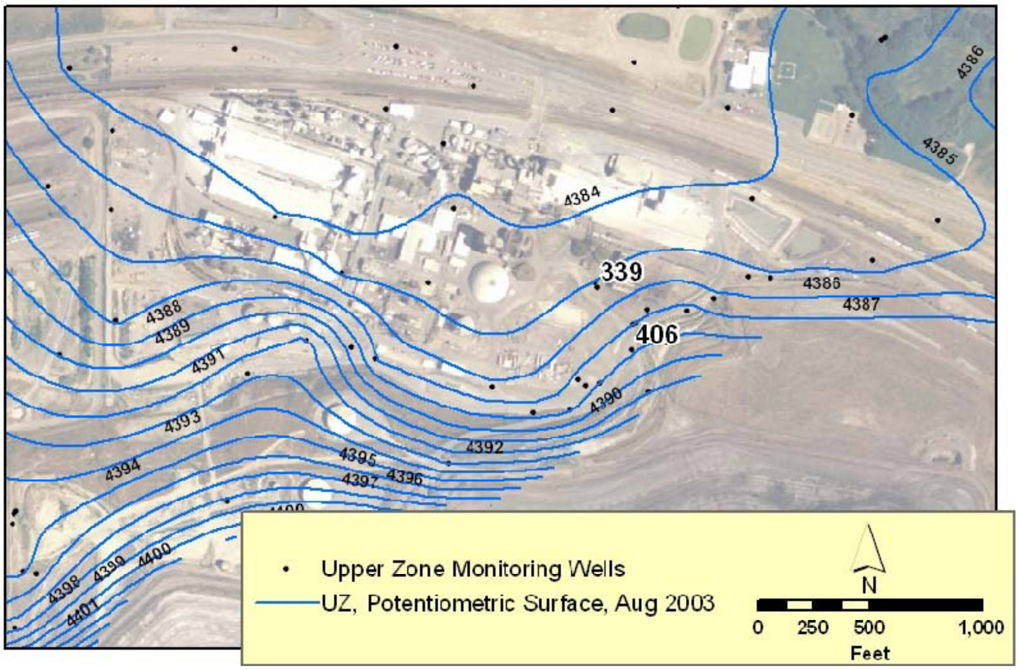


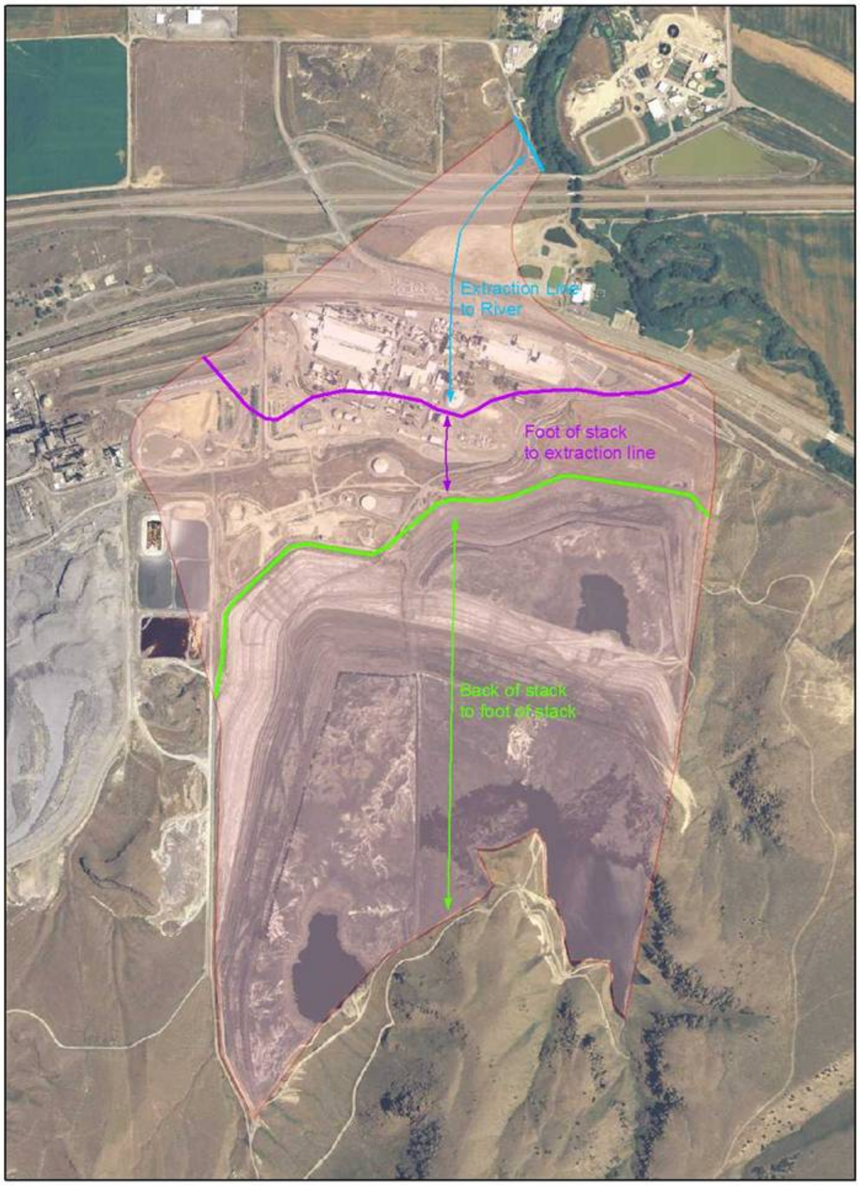
Figure 3-73: Locations of extraction-well 406 and well 339 used to assess arsenic and sulfate attenuation.

Sulfate concentrations decline from approximately 2,900 mg/L at well 406 to 2,700 mg/L at well 339. Sulfate removal from groundwater may occur by mineral precipitation or sorption to existing mineral surfaces. At wells 406 and 339, sulfate mineral phases such as anhydrite and gypsum appear to be at equilibrium. This result indicates that sulfate precipitation and dissolution reactions are most likely controlling sulfate concentrations in groundwater along this flow path, and sulfate attenuation most likely occurs by precipitation of sulfate minerals.

Arsenic attenuation typically occurs by either co-precipitation with other minerals or sorption. When the more oxidized form of arsenic, As(V), is present in groundwater as a charged oxy-anion, common iron oxy-hydroxide minerals provide sorption sites. The arsenic concentrations at well 406 and well 339 are essentially the same (0.43 mg/L and 0.45 mg/L, respectively), and there appears to be no, or negligible, arsenic attenuation along this pathway. There are no arsenic-bearing mineral phases that are predicted to precipitate from (or dissolve into) groundwater along this flow path. Precipitation of iron oxy-hydroxide type minerals from groundwater is predicted by aqueous speciation modeling. However, the low iron content of groundwater, at both 406 and 339, will limit the amount of iron oxy-hydroxide minerals that can form and provide sorption sites for arsenic (and other groundwater constituents). Therefore, arsenic sorption to these minerals is probably limited by the low supply of new iron oxy-hydroxide surfaces and new sorption sites. This may also be the limiting factor for arsenic attenuation farther downgradient of the extraction-well line. For the purposes of this initial estimate, it has been assumed that there is no attenuation of arsenic in groundwater downgradient of site sources. This will undergo a more detailed evaluation as part of the final design analyses.

3.3.5.3 Groundwater Travel Time

Groundwater travel times are estimated by subdividing the flow path from the back of the gypsum stack to the river into three areas: from the back of the stack to the foot of the stack, from the foot of the stack to the line of assessment in the target capture zones, and from the target capture zones to the river. For each of the three areas, a hydraulic conductivity, hydraulic gradient and effective porosity were estimated based on the available water level, pumping test, and soil analytical data. Parameters were extrapolated over the areas shown in Figure 3-74.



Notes on figure: Three transport areas include (1) from the back of the stack to the foot of the stack (green), (2) from the foot of the stack to the extraction line (purple), and (3) from the extraction line to the river (blue).

Figure 3-74: Groundwater plume area.

The calculation of groundwater travel times is performed as follows:

1. Hydraulic conductivity (K) values were estimated for the three areas in the Upper Zone, Lower Zone, and bedrock. The mass flux analysis (Appendix B) provides estimates of hydraulic conductivity based on aquifer test data in the Upper and Lower Zones north of the gypsum stack. Beneath the gypsum stack, the aquifer is primarily fractured bedrock,

and the hydraulic conductivity was assumed to be 1.6 ft/day, based on slug and packer tests conducted in bedrock wells (142, 304, 306, 323, and 351).

2. The hydraulic gradient (i) was estimated for each of the three areas in the Upper and Lower zones. The hydraulic gradients have been calculated for each of the target capture zone areas (Appendix B). The hydraulic gradient for the bedrock area was estimated based on water level data from wells 300 and 332 taken in 1992. Wells 300 and 306 are the only wells completed in the saturated zone beneath the gypsum stack in which groundwater level data have been obtained. These wells were abandoned in 1995.

3. Effective porosities (n_e) were estimated from Tier 2 soil analytical data from the PAP Investigation. For the bedrock, values were based on a range of typical effective porosity values for fractured crystalline rock from Schwartz and Zhang (2003).

4. Average linear groundwater velocity was calculated as:

$$v = Ki/n_e \qquad [11]$$

Table 3-6 presents the estimated groundwater travel times for each of the three areas, and for the total flow path from the back of the stack to the river. Groundwater travel times from the stack to the river suggest that mass removal at the stack will take 2.1 to 13.2 years to show an effect at the river.

Table 3-6: Summary of groundwater travel times and parameters used in calculation.

Zone	Segment	Effective porosity		Hydraulic conductivity (ft/day)	Gradient (ft/ft)	Average linear groundwater velocity (ft/day)		Flow Length (ft)		Travel time (years)	
		min	max	average	Average	min	max	min	max	min	max
Upper Zone	Back of Stack to foot of stack	0.005	0.01	1.6	0.0200	3.2	6.4	3,100	5,200	1.33	4.5
Upper Zone	Foot of stack to Extraction line (wells 412, 411, 410, 414)	0.20	0.26	200.0	0.0060	4.6	6.0	500	2,300	0.2	1.4
Upper Zone	Extraction Line (wells 412, 411, 410, 413, 414) to River	0.20	0.26	2,300.0	0.0010	8.8	11.5	2,200	3,600	0.5	1.1
									TOTAL	**2.1**	**6.9**
Lower Zone	Back of Stack to foot of stack	0.005	0.01	1.6	0.0200	3.2	6.4	3,100	5,200	1.33	4.5
Lower Zone	Foot of stack to Extraction line (wells 412, 411, 410, 414)	0.20	0.26	100.0	0.0048	1.8	2.4	500	2,300	0.6	3.4
Lower Zone	Extraction Line (wells 412, 411, 410, 413, 414) to River	0.20	0.26	100.0	0.0048	1.8	2.4	2,200	3,600	2.5	5.3
									TOTAL	**4.4**	**13.2**

4.0 REMEDIAL DESIGN

As described in Section 1.2, the design of the groundwater extraction system has been conducted using a "phased and integrated approach" (EPA 1997). In this approach, test extraction wells have been installed and operated to provide location-specific performance data. Monitoring wells and exploratory borings have also been installed in phases to address specific data gaps in the site conceptual model for groundwater. The purpose of this "final design" is to present an evaluation of the existing systems with respect to meeting the remedial objectives and propose a scope of work that is expected to fill any deficiencies in the groundwater extraction and monitoring systems. Uncertainties in the CSM have been greatly reduced with the completion of each phase of the extraction and monitoring systems and sufficient information is now available to both design the remaining elements of the remedial systems and demonstrate that the complete system will meet remedy objectives. While this scope is expected to be the final phase, contingencies for additional work are included based on the results of performance monitoring.

4.1 Groundwater Extraction System

The groundwater extraction system currently consists of 14 test extraction wells that were installed in two prior phases of work; Phase 1 in 2003-2004 and Phase 2 in 2007-2008. The locations of the test wells are shown in Figure 4-1. Performance and monitoring data have been collected since June 2004. Additional extraction needs are based on a detailed evaluation of the performance of the existing test wells. This evaluation and the scope of additions to the system are discussed in the following sections. Additional extraction system design details are also provided.

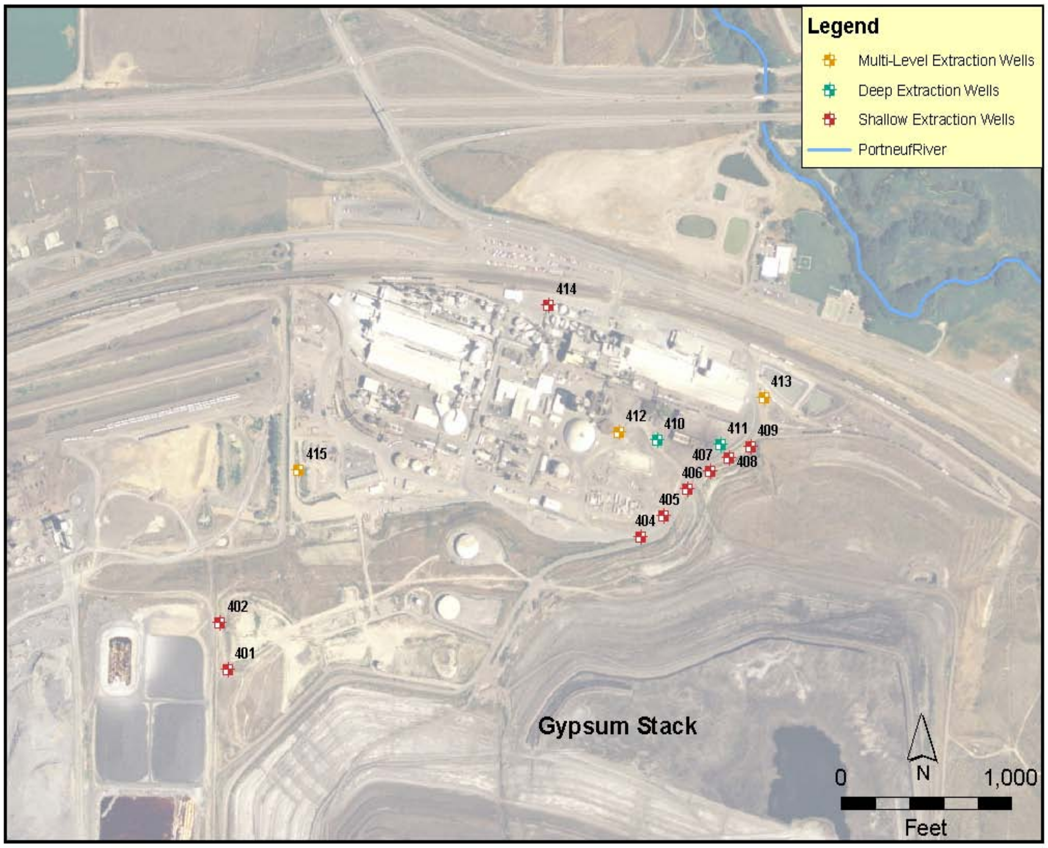


Figure 4-1: Extraction wells in the current (2008) extraction system.

4.1.1 Evaluation of the Test Groundwater Extraction System

An evaluation of performance and monitoring data was performed generally following the six-step process detailed in *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (EPA 2008). The six steps are as follows:

- Step 1: Review site data, site conceptual model, and remedy objectives
- Step 2: Define site-specific Target Capture Zone(s)
- Step 3: Interpret water levels
    - Potentiometric surface maps (horizontal) and water level difference maps (vertical)
    - Water level pairs (gradient control points)

- Step 4: Perform calculations
  - Estimated flow rate calculation
  - Capture zone width calculation (can include drawdown calculation)
  - Modeling (analytical or numerical) to simulate water levels, in conjunction with particle tracking and/or transport modeling
- Step 5: Evaluate concentration trends
- Step 6: Interpret actual capture based on Steps 1-5, compare to Target Capture Zone(s), assess uncertainties and data gaps

The information contained in Sections 1 through 3 of this report constitutes Step 1 in the process. Summaries of the evaluations and calculations that were performed as part of Steps 2 through 6 are provided in the following paragraphs.

4.1.1.1 Delineation of Target Capture Zones

Target capture zones are three-dimensional zones within the regime of affected groundwater flow where groundwater extraction will be focused to satisfy the requirements of the remedy. The target capture zones for the Simplot Plant Area were determined based upon multiple hydrogeologic criteria. The zones take into account all known EMF Site data, the CSM, and the remedy objectives (EPA 2008).

The lateral delineation of the site target capture zones are shown in Figure 4-2 for the Upper Zone and Figure 4-3 for the Lower Zone. The lateral extent of Upper and Lower Zone target capture zones are situated to be close to and downgradient of potential source locations, to completely encompass the flow paths of all affected groundwater from potential source areas (as delineated observed distributions of COCs), and areas that allow the access to subsurface hydrostratigraphic units that best suit groundwater extraction.

Upper Zone target capture zones are located at the toe of the gypsum stack with the exception of the zone that has been shifted north to accommodate potential sources in the Phosphoric Acid Plant area of the facility. The Lower Zone target capture zones are also located at the toe of the gypsum stack. Eastern and western target capture zones have been shifted to the south and north, respectively, to provide for access to hydrostratigraphic units that are suitable for groundwater extraction.

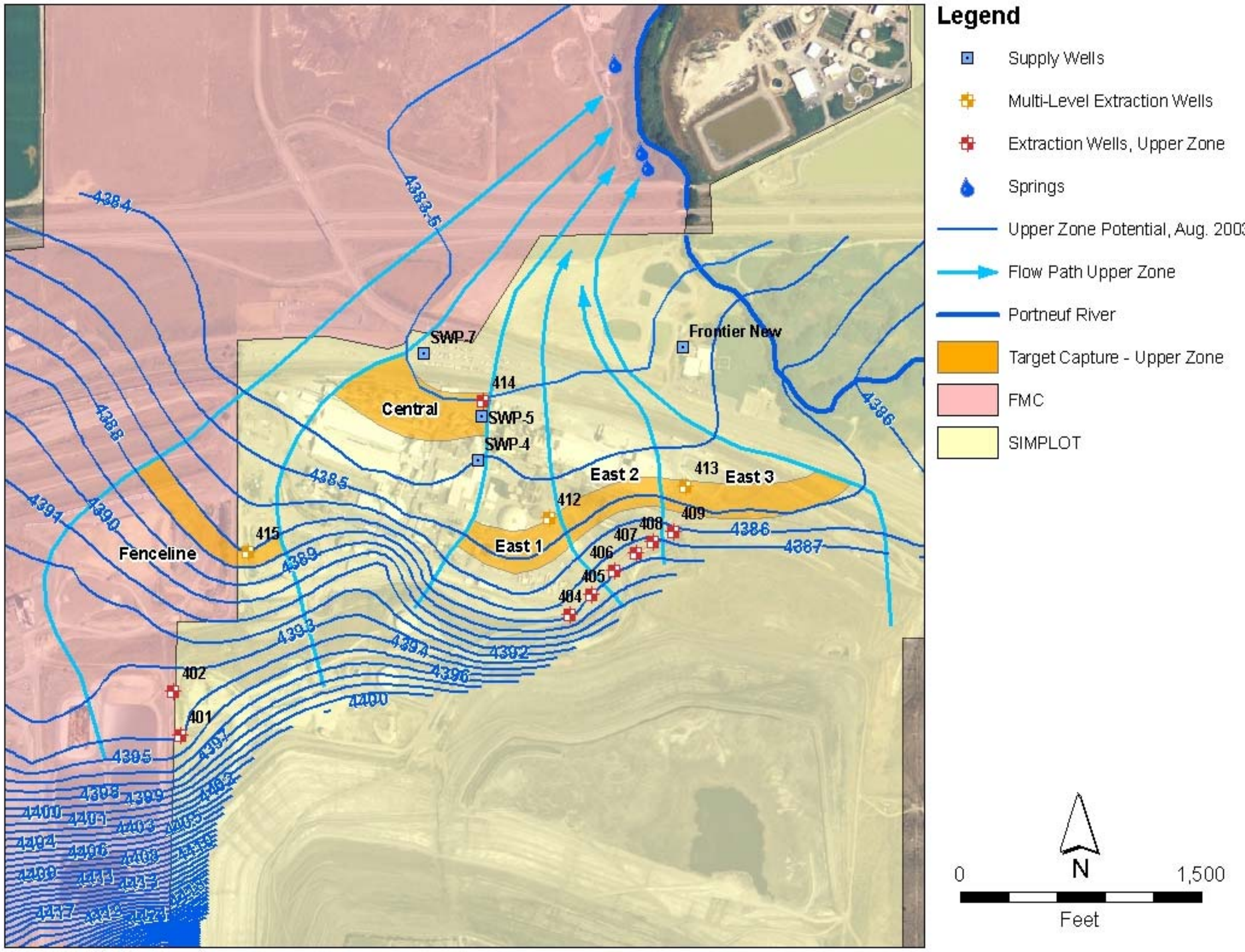


Figure 4-2: Target capture zones for the Upper Zone.

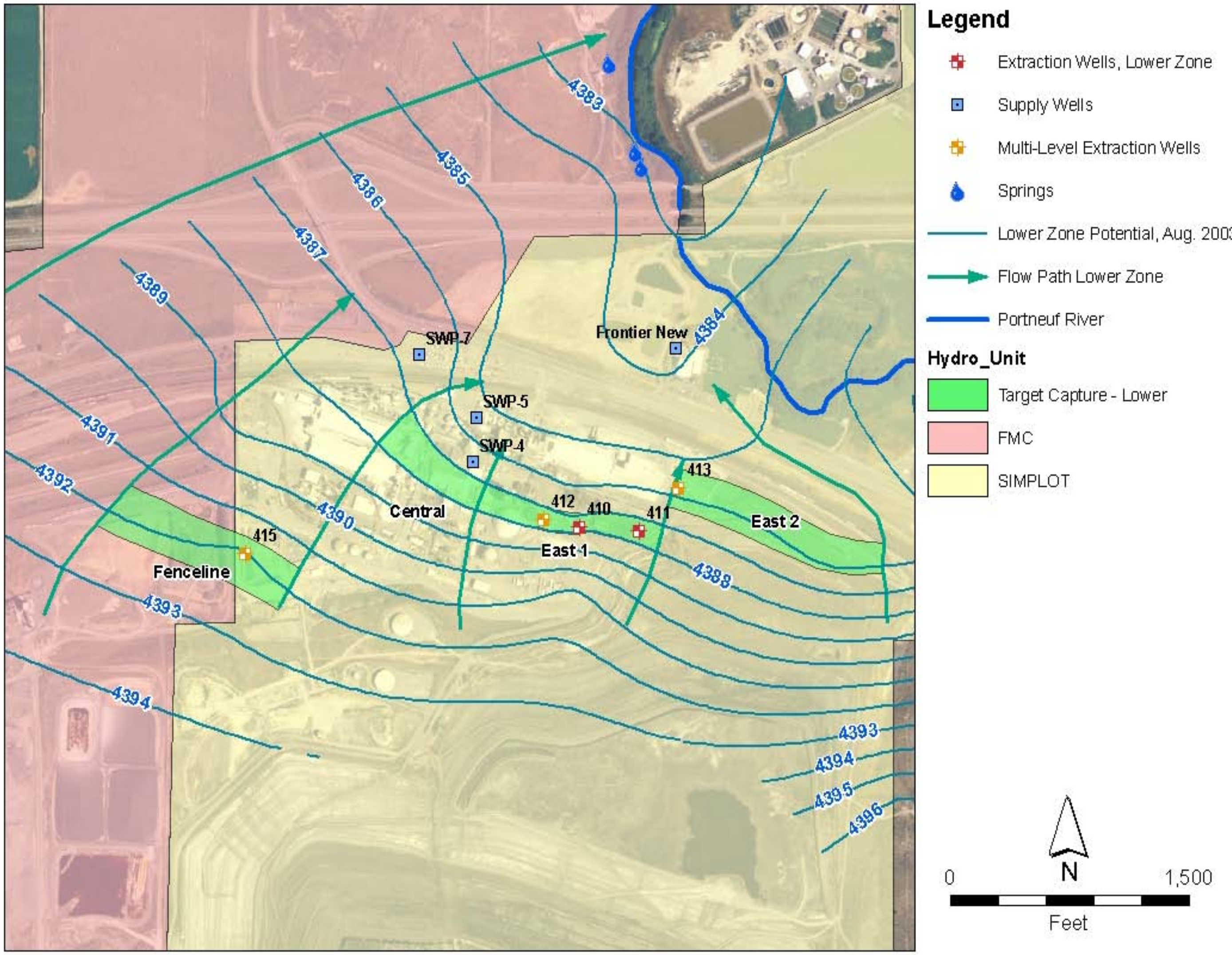
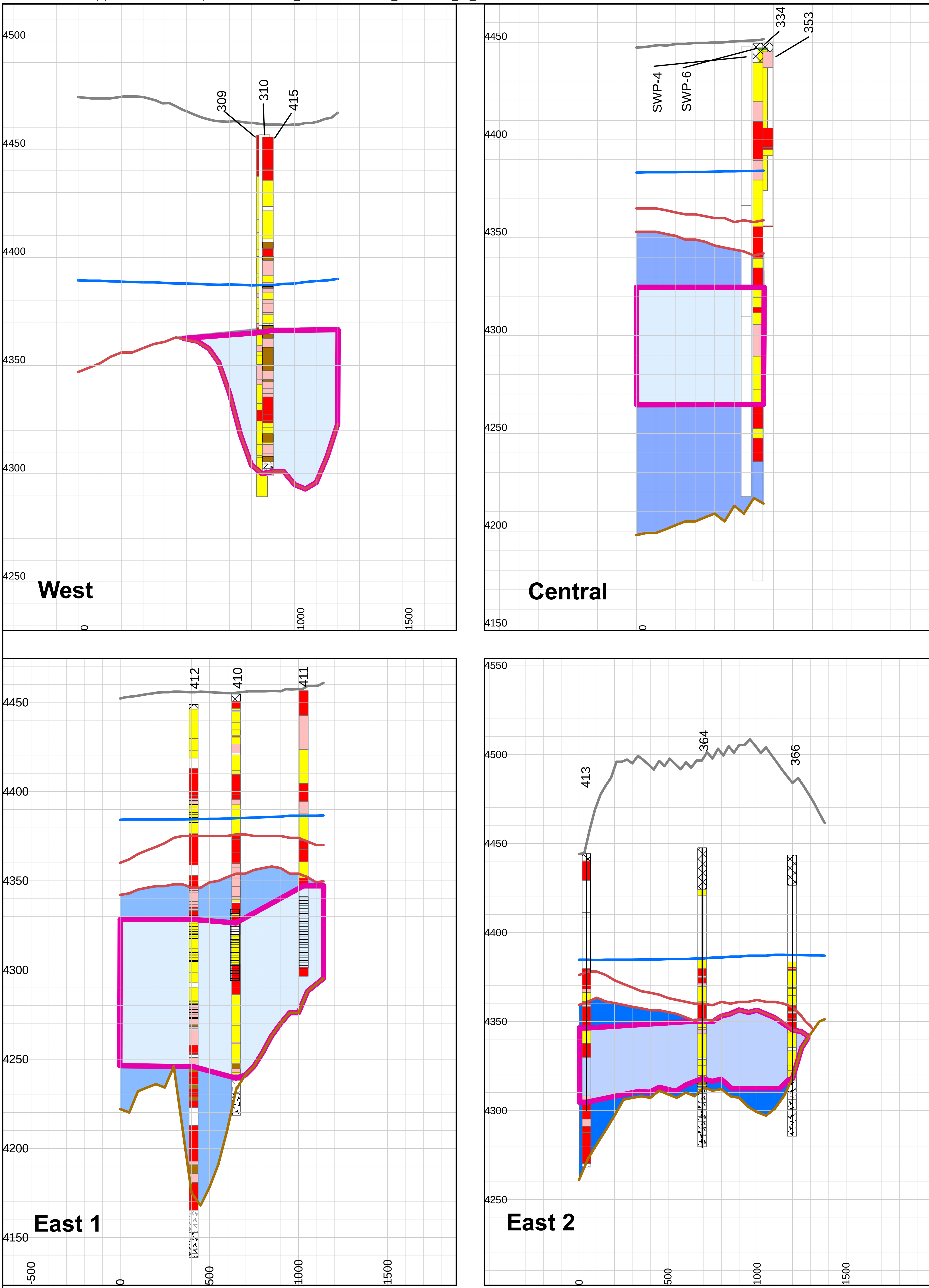
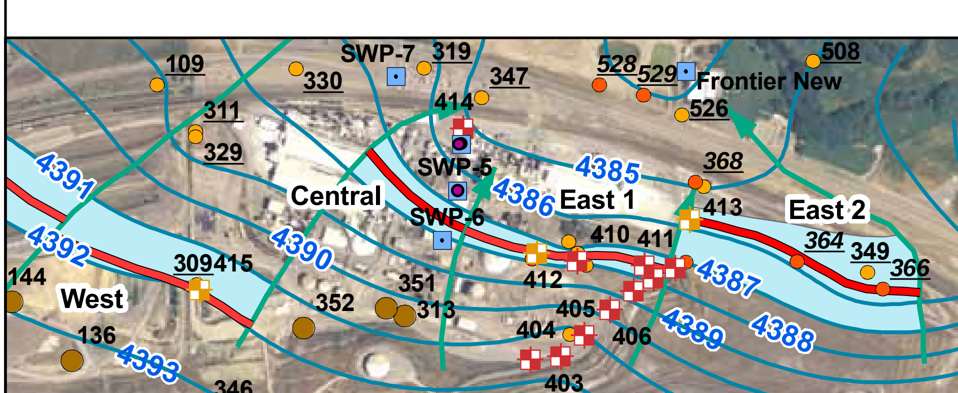


Figure 4-3: Target capture zones for the Lower Zone.

The vertical extent of target capture zones for the Upper Zone include the entire saturated thickness above the AFLB, since hydraulic conductivities in this unit are moderate to high (NewFields 2008a). For the Lower Zone, the vertical extent of target capture zone is controlled by aquifer transmissivity: target capture zones are focused on areas with higher transmissivities to enable maximum flow containment. The vertical capture zone for lower zone west, central and east sections are shown in Figure 4-4. The target capture zones in the Lower Zone essentially include all of the strata that would be screened by an extraction well and exclude only lenses of clay and silt rich material that yield little groundwater and contribute little in the way of the transport of site-derived constituents.. Aquifer testing performed at well 412 during the Phase 2 Data Gap Investigation (NewFields 2008a) demonstrated that pumping has a hydraulic effect in the clay and silt rich units, even though the extraction well was not screened in those intervals.





Legend

Flow Zones

- Low Transmissivity
- High Transmissivity
- Target Capture Zone

J.R. SIMPLOT

EASTERN MICHAUD FLATS

FIGURE 4-4

LOWER ZONE VERTICAL EXTENT OF TARGET CAPTURE ZONES

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FORMATION ENVIRONMENTAL

4.1.1.2 Interpretation of Groundwater Potential

The current extraction system was fully operational when site-wide groundwater levels were measured during the second quarter groundwater monitoring event on May 19, 2008. The large scale groundwater potentiometric surface maps presented in the second quarter groundwater monitoring report are shown in Figures 4-5 and 4-6.

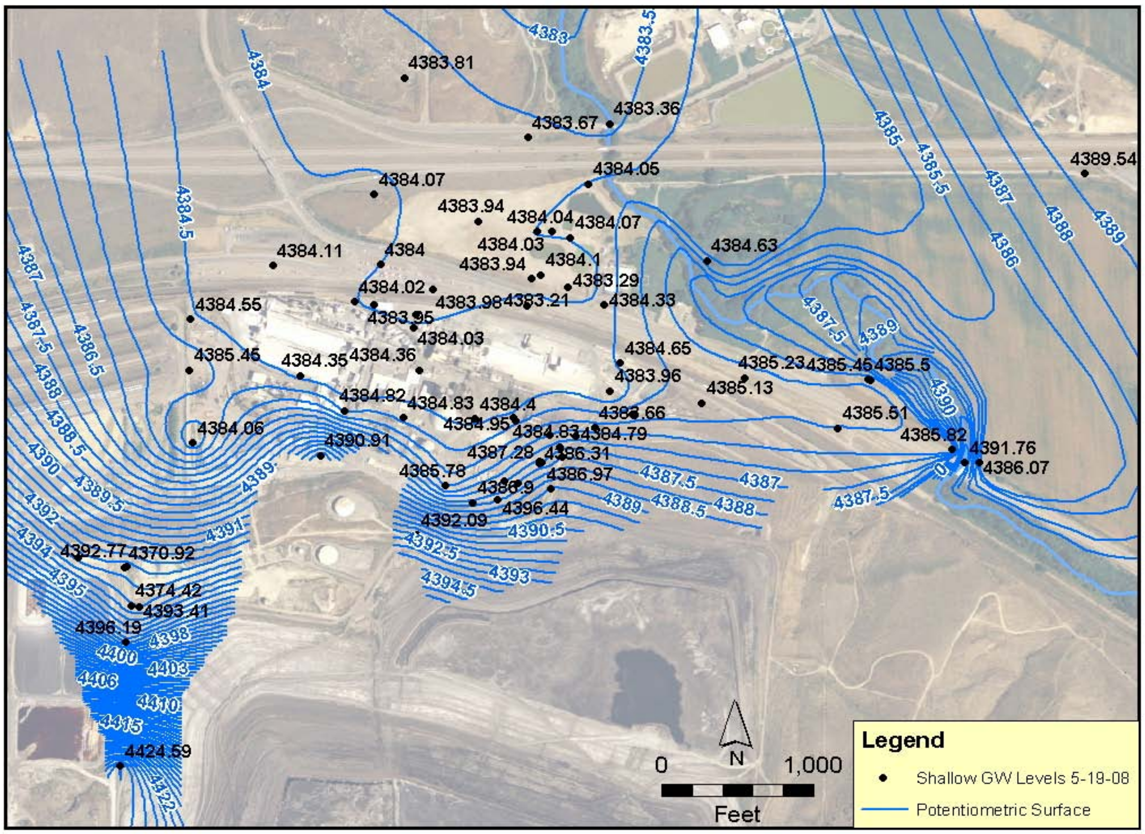


Figure 4-5: Interpreted potentiometric surface for the Upper Zone, second quarter 2008.

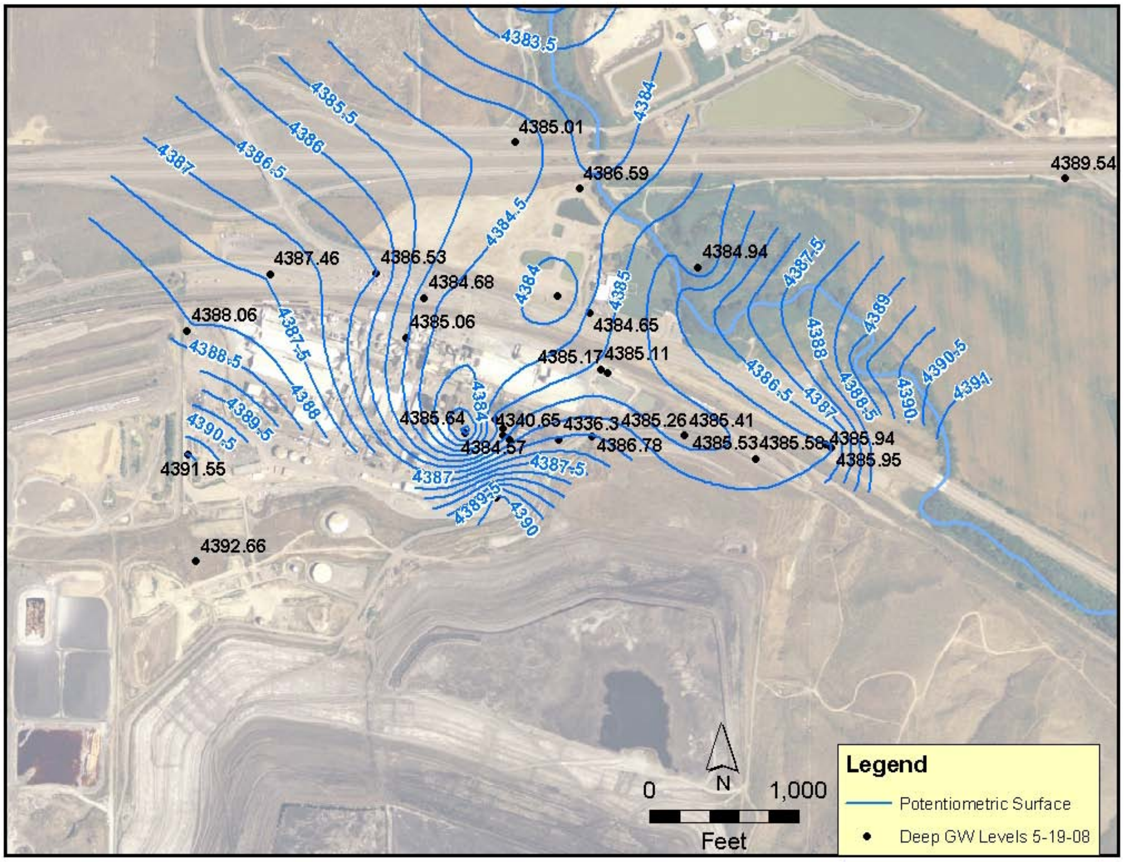


Figure 4-6: Interpreted potentiometric surface for the Lower Zone, second quarter 2008.

Water level data from the extraction wells themselves are not used to make the potentiometric surface maps. The potentiometric surfaces were examined near each of the pumping centers and drawdown data from the pumping tests completed in April 2008 (NewFields 2008a) and December 2005 (NewFields 2006a) and edited where necessary to display the effects of pumping near the pumping wells in additional detail at a smaller scale.

A summary of the drawdown observed in and near pumping wells during aquifer tests is provided in Table 4-1. Local, small scale potentiometric surface maps are shown in Figures 4-7 through 4-12.

Table 4-1: Summary of drawdown observed during pumping tests

Pumping Well	Pumping Rate (gpm)	Monitoring Station	Zone	Distance from Pumping Well (ft)	Observed Drawdown (ft)
412	510	339	UZ	258.5	0.4
		344	LZ	286.9	0.72
		362	UZ	19.5	1
		410	LZ	234.5	1
		412	Multilevel	0	19.4
		361A	LZ	29.5	3
		361B	LZ	29.5	3
		361C	LZ	29.5	2.72
		361D	LZ	29.5	0.35
413	125	317	LZ	201.8	0.2
		318	UZ	195.2	0
		326	LZ	197.3	
		365	UZ	24.2	0.72
		411	LZ	358.9	0.15
		413	Multilevel	0	17.6
		363A	LZ	233.3	0.16
		363B	LZ	233.3	0.11
		363C	LZ	233.3	0.11
		368A	LZ	214.7	0.05
		368B	LZ	214.7	0.05
414	34	334	UZ	285.8	0
		340	UZ	382.8	0
		348	UZ	204.7	0
		414	UZ	0	1.3
		335D	LZ	91.1	0
		335S	UZ	91.1	0
415	50	308	UZ	911.9	0
		309	LZ	59.6	0
		310	UZ	46.9	2.65
		324	UZ	544.4	0.2
		346	LZ	646.5	0
		352	UZ	613.7	0
		415	Multilevel	0	3.2

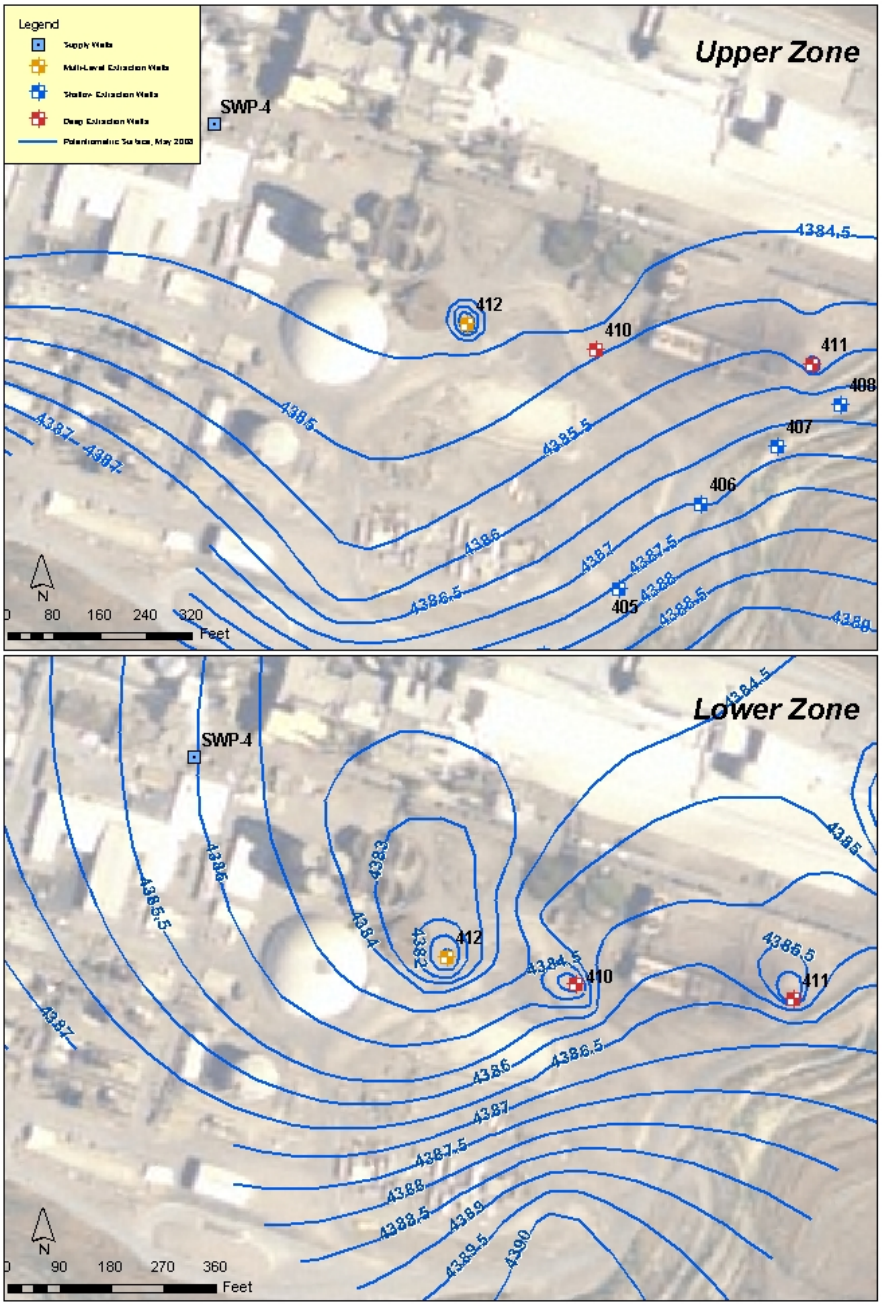


Figure 4-7: Upper and lower zone potentiometric surface for 2008 pumping conditions near well 412.

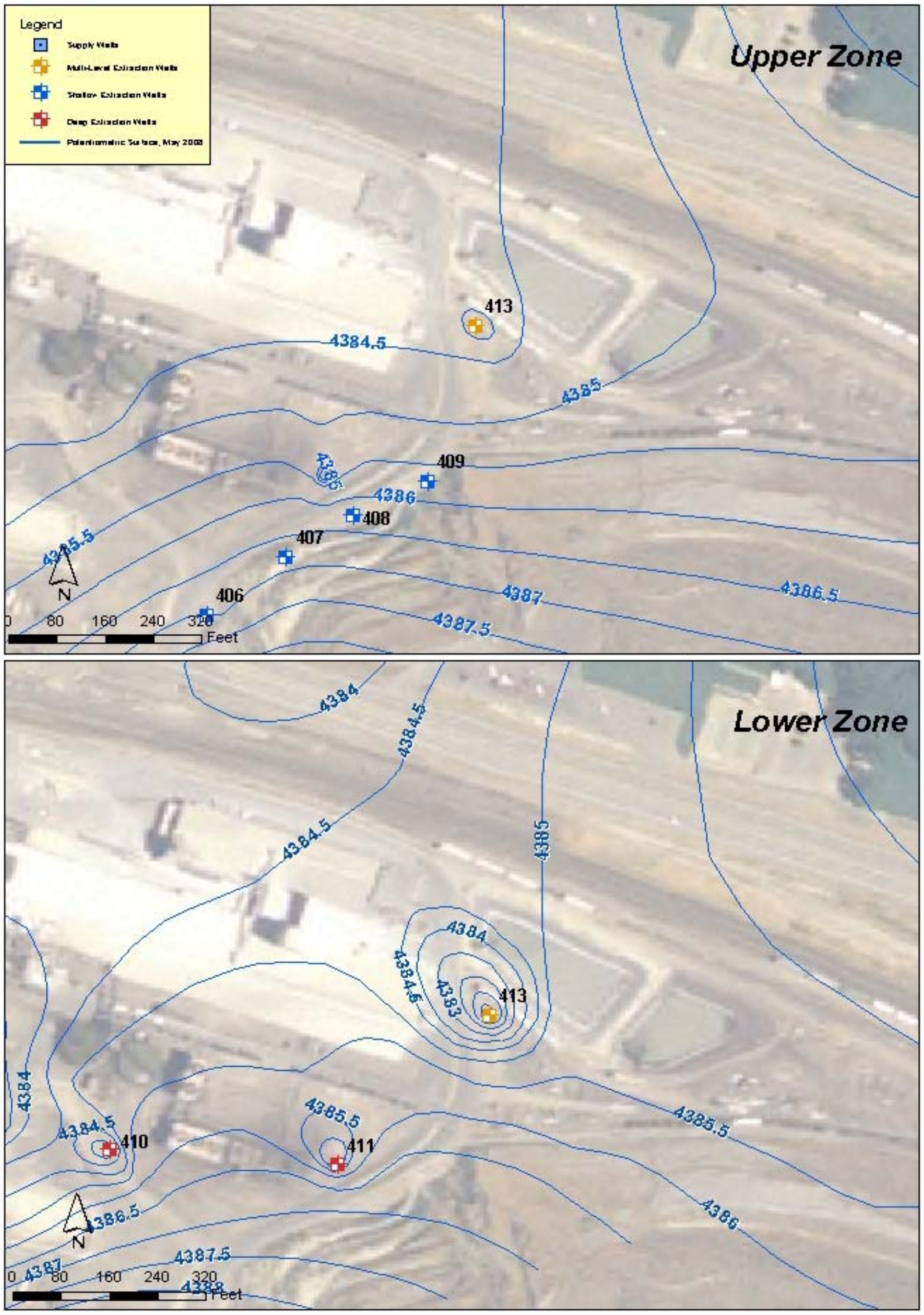


Figure 4-8: Upper and Lower zone potentiometric surface for 2008 pumping conditions near well 413.

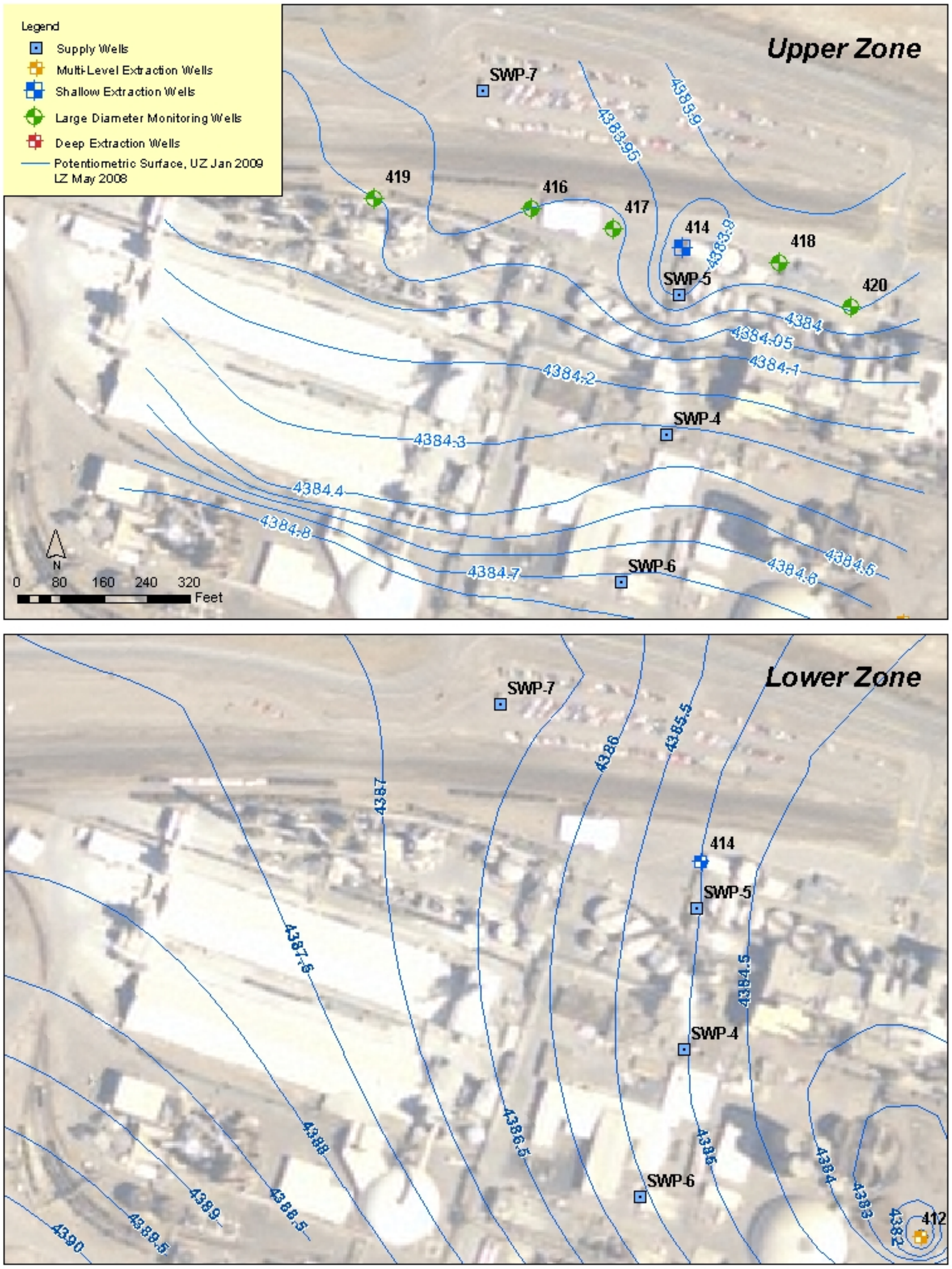


Figure 4-9: Upper and Lower zone potentiometric surface for 2008 pumping conditions near well 414.

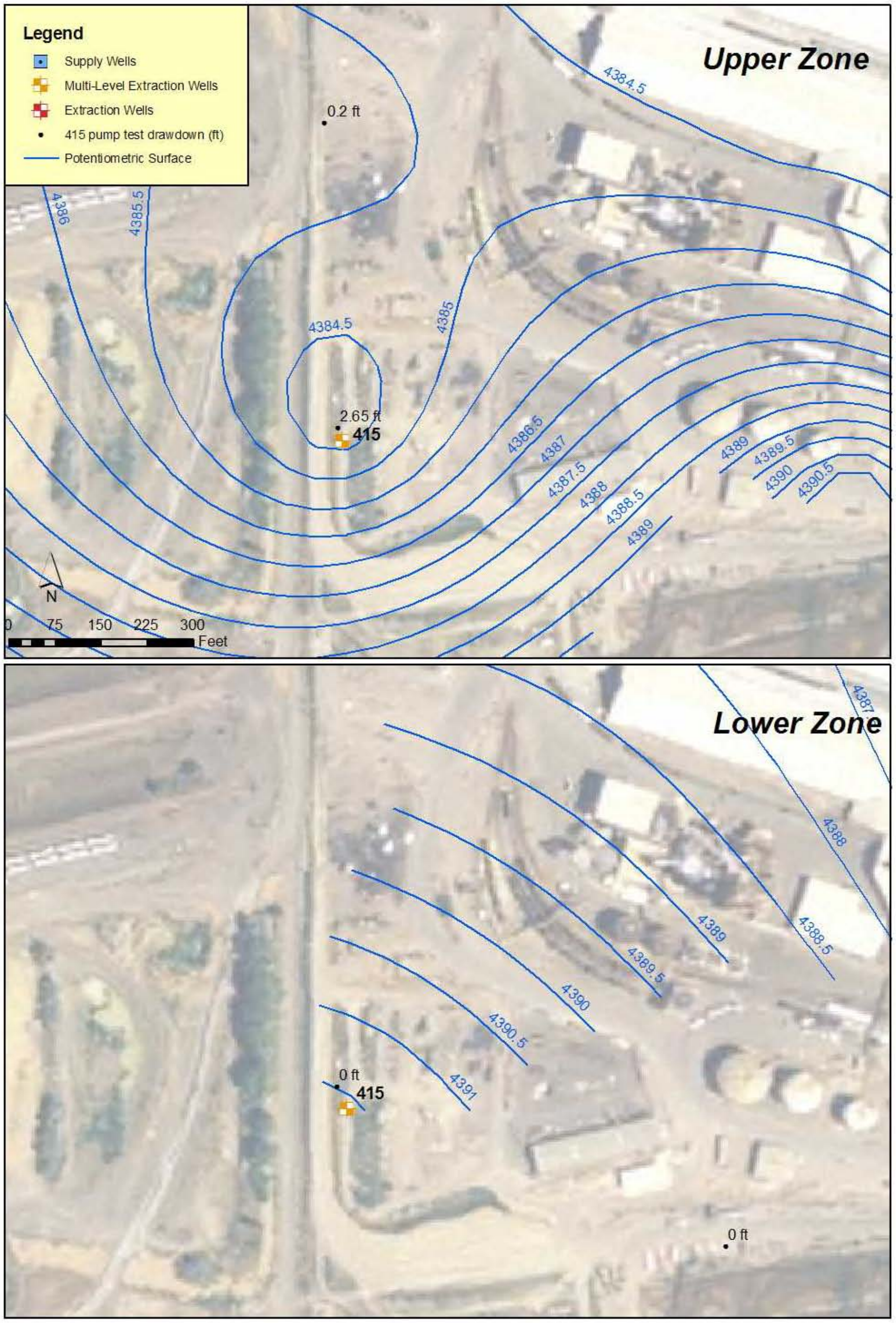


Figure 4-10: Upper and lower zone potentiometric surface for 2008 pumping conditions near well 415.

The detailed maps of the potentiometric surfaces in the vicinity of major pumping wells can be used to estimate the hydraulic influence of each well. Pumping wells in the Upper Zone produce a limited area of influence. Well 412 produces a substantial amount of the Lower Zone influence with wells 410, 411, and 413 producing a less observable effect, partially due to the density of the monitoring well network. The effect of pumping at well 414 (Upper Zone) is also hard to measure due to the distance at which observations could be made. Well 415 produces a substantial amount of drawdown, as measured at nearby observation wells, but has little effect on the Lower Zone.

4.1.1.3 Groundwater Flow and Mass Flux

The current effect of the test extraction can also be assessed in terms of the removal of constituents from the target capture areas. The mass flux calculation can be continually revised to indicate how mass is being removed from the system, how much mass is remaining in groundwater, and provides a basis for evaluating the effect on downgradient groundwater concentrations if no further groundwater extraction is provided. In the calculation for 2008 conditions assumes the following:

- Average quarterly extraction flow rate for the third quarter of 2008 (NewFields 2008c),
- Constituent concentrations are based on the third quarter 2009 monitoring results for most wells, January 2009 data for new PAP Area wells,
- The mass load lost to attenuation is assumed to be the same percentage of the total mass flux near the source area as calculated for the pre-extraction system.

The calculation is included in Appendix B.

The 2008 mass flux model was also revised based on new groundwater chemistry data obtained from the Upper Zone central target capture zone during the PAP Investigation (Simplot 2009). Results of the groundwater sample analyses are provided in detail in Appendix B. The PAP Area groundwater chemistry data indicate that influences of PAP Area sources currently have a limited areal extent but relatively large phosphorus load effect and that most areas exhibit only the effect of gypsum stack influence. The mass flux calculation in the central Upper Zone was also revised to take into account the load and attenuation phosphorus from PAP sources, which is different than the load and attenuation of phosphorus from the gypsum stack. PAP sources, which are characterized by low pH and high total phosphorus concentration, attenuate rapidly through reaction mechanisms with naturally occurring calcite minerals in the subsurface. This attenuation rate, which is estimated to be greater than 90%, is accounted for when comparing the phosphorus load in groundwater to the phosphorus load in the Portneuf River.

Based on the revised current (2008) groundwater conditions, the mass flux model predicts that the removal rate for the phosphorus load observed in the target capture areas in groundwater is about 61%, including PAP sources. This calculation can be used going forward to identify areas where additional extraction may be beneficial.

4.1.1.4 Well Capture Calculations

Although the mass balance calculation takes spatial variability of hydraulic properties into account by dividing the well capture line into multiple target capture zones, a more rigorous understanding of the spatial extent of capture by the existing and proposed wells is necessary to determine the overall effectiveness of the system at mitigating the plume.

<u>Analytical Calculations</u>

Well capture zones depend on the groundwater hydraulic gradient in addition to the observed drawdown due to pumping. The width and length of a capture zone can be calculated after accepting some simplifying assumptions (Javandel and Tsang 1986):

- The aquifer is homogeneous, isotropic, confined and of infinite extent
- The aquifer is of uniform thickness
- Extraction wells are fully penetrating
- The regional hydraulic gradient is uniform and steady-state
- The vertical gradient is negligible
- There is no net recharge
- There are no other sources of water to the aquifer.

The calculation is based on the transmissivity of the aquifer, saturated thickness, regional hydraulic gradient, and extraction rate. Aquifer parameters were estimated to perform the mass flux calculations (Appendix B), and extraction rates were based on average rates for the second quarter of 2008 (NewFields 2008b). Results of the calculations are included in Appendix C and summarized in Table 4-2. Y_{max} represents the maximum capture zone width from the central line of the plume (half of total width); Y_{well} is the capture zone width at the location of the well from the central line of the plume (half of total width); and X_o represents the distance from the well to the downgradient end of the capture zone along the central line of flow (Javandel and Tsang 1986). The calculated extent of the capture zones has been superimposed on May 2008 potentiometric surface map in Figure 4-11.

Table 4-2: Summary of extraction well capture zone dimensions

Zone	East 1		East 3		Central	West	
	UZ	LZ	UZ	LZ	UZ	UZ	LZ
Extraction well	***412***	***412***	***413***	***413***	***414***	***415***	***415***
Y_{max} (ft)	90	685	544	411	498	116	215
Y_{well} (ft)	45	342	272	206	249	58	107
X_o (ft)	29	218	173	131	158	37	68

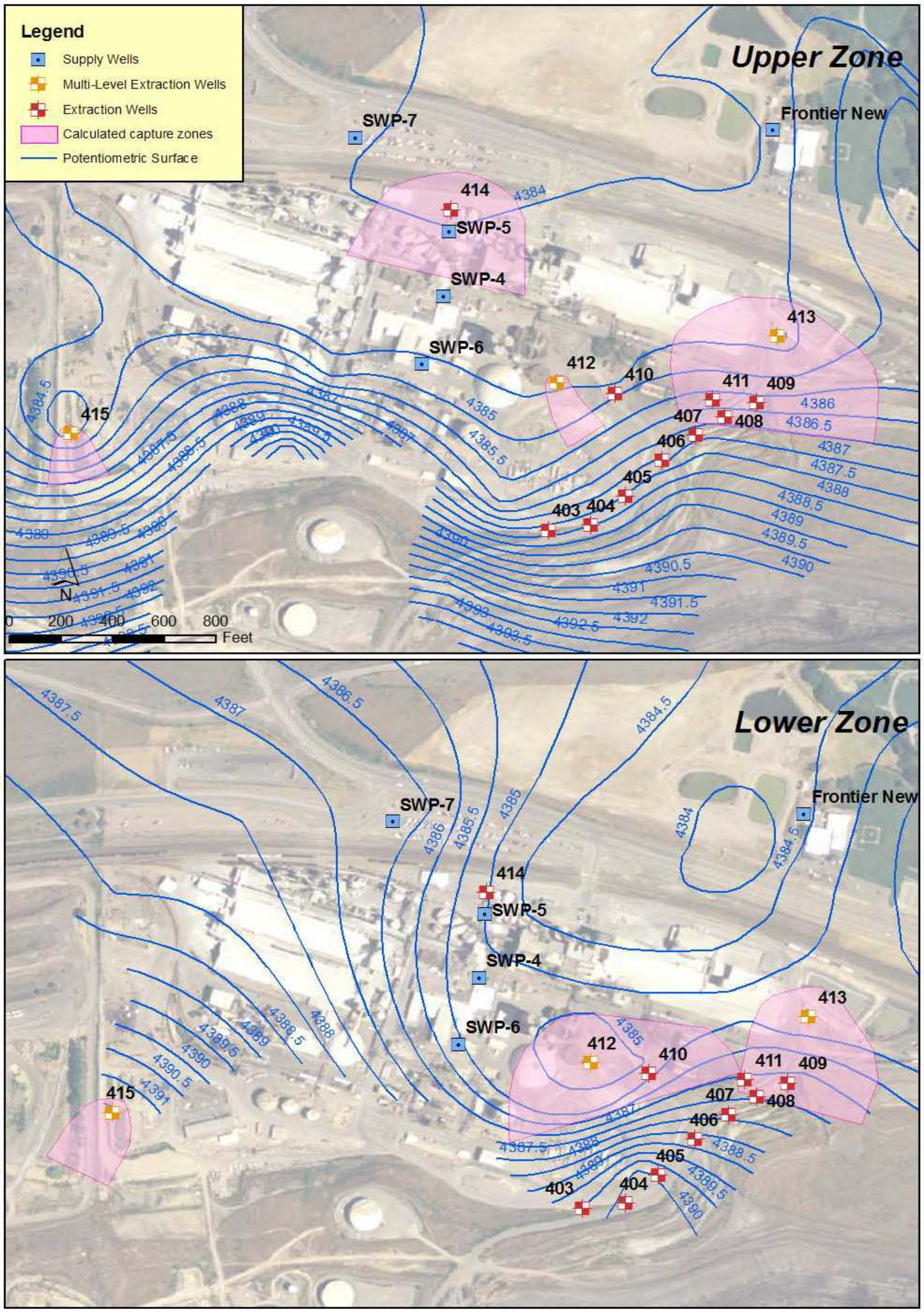


Figure 4-11: Calculated capture zones for extraction wells 410, 411, 412, 413, 414, and 415 in the Upper and Lower Zones.

<u>Numerical Particle Tracking Models</u>

Numerical groundwater flow and particle tracking models were developed in an attempt to provide more realistic and site-specific assessment of the extent of extraction well capture zones. The numerical modeling technique allows for direct representation of the hydrostratigraphy of the site, variations in hydrogeologic properties, and for the simulation of complex boundary conditions. The groundwater flow model Modflow (McDonald and Harbaugh 1988) was used in conjunction with the particle tracking model Modpath (Pollock 1994) inside the pre- and post-processing software Groundwater Vistas (ESI 2007) to provide the simulations.

Three groundwater flow models were developed, one to simulate Upper and Lower Zone groundwater flow in the eastern target capture zones (to simulate the performance of wells 404 through 413), one to simulate Upper Zone groundwater flow in the central target capture zone (to simulate the performance of well 414), and one to simulate Upper and Lower Zone groundwater flow in the western target capture zones (to simulate the performance of well 415). The model areas were set up based on a telescoping methodology, where local boundaries are defined from observed flow conditions in the site-wide groundwater flow regime. The separate model area setup allows the use of a fine numerical grid mesh (both laterally and vertically) which is important in simulating groundwater head and velocity near pumping wells. Models were calibrated to steady-state conditions observed in August 2003 and were then modified to simulate current pumping conditions (2008) by adding extraction wells with steady-state pumping rates allocated to the appropriate screened intervals. A detailed description of the setup of these models is included in Appendix D. A summary of the results of the particle tracking modeling for each of the three model areas is provided in the following sections.

Eastern Target Capture Zones Model

The eastern target capture zones model is comprised of 7 layers, the top layer simulates the Upper Zone, layer 2 simulates the AFLB, layers 3-5 simulate the Lower Zone, and layers 6 and 7 simulate the Tertiary bedrock. Layer elevations are directly input from the site hydrostratigraphic model (see Section 3-3). The lateral grid spacing is uniform at 25 feet in both the x and y directions. Constant head boundaries are provided at both the upgradient and down gradient limits of the model in layers 1 through 4 and at the bottom of model in layer 7 to provide the observed lateral and vertical hydraulic gradients. Hydraulic conductivities vary throughout the model and are based on aquifer testing results. Forward particle tracking is employed to observe the effects of pumping wells. A continuous line of simulated particles was placed at the southern edge of the modeled area. Particles were released at 10 vertical intervals within the Upper and Lower Zones. The dense network of particles released upgradient of the pumping wells allows a visualization of well capture zones as well as areas where groundwater is not captured.

The results of particle tracking for a simulation with wells 410, 411, 412, and 413 pumping is shown in Figures 4-12 and 4-13. Orange particle traces are captured by existing pumping wells; blue particle traces are not captured. The results indicate that the wells do not capture all particles in the Upper Zone, but completely capture all particles in the Lower Zone. Note that the Upper Zone extraction wells 404-409 were not pumping in this simulation and the water production well SWP-4 is not in the model domain.

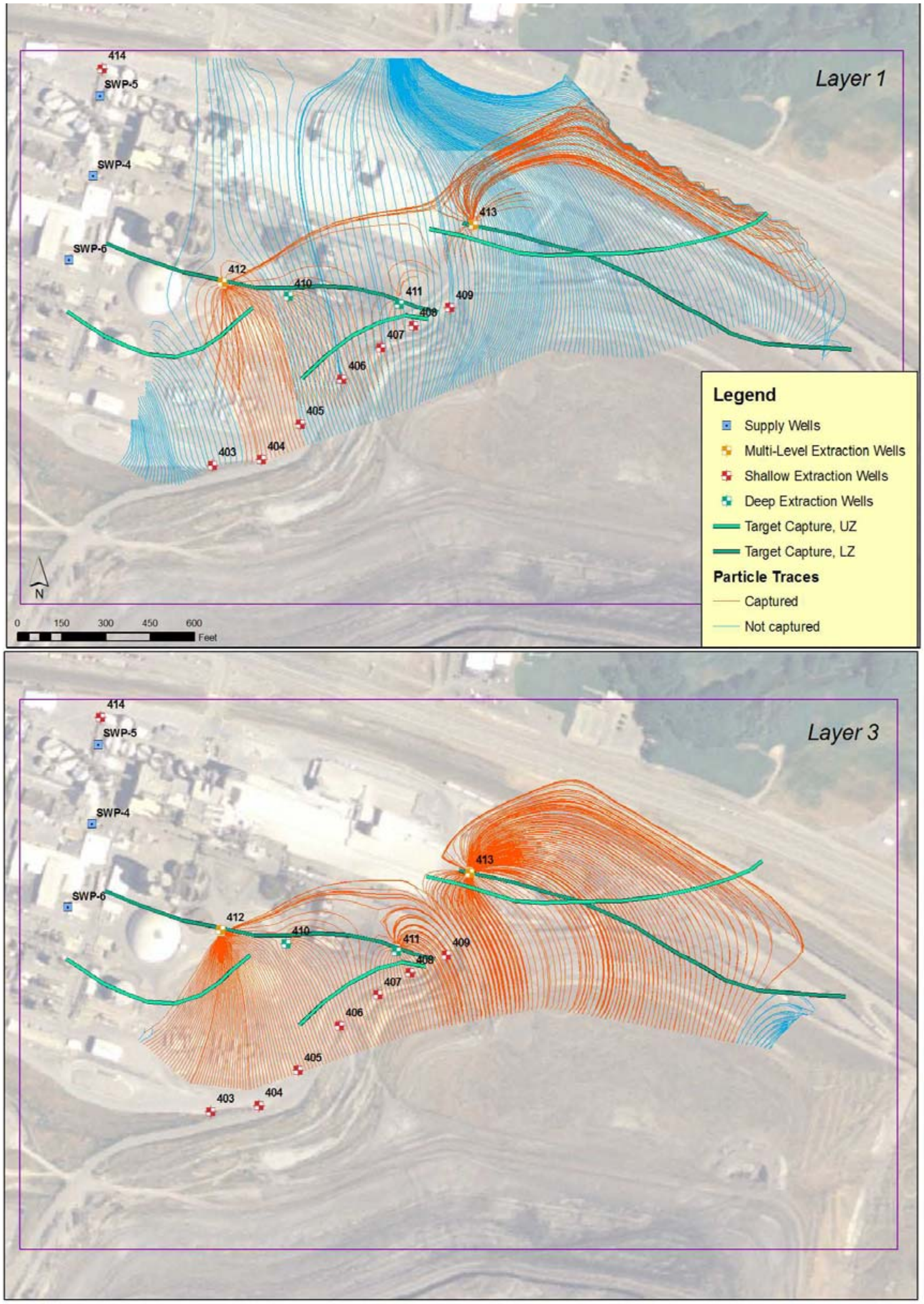


Figure 4-12: Results of particle tracking simulation in the eastern target capture zones

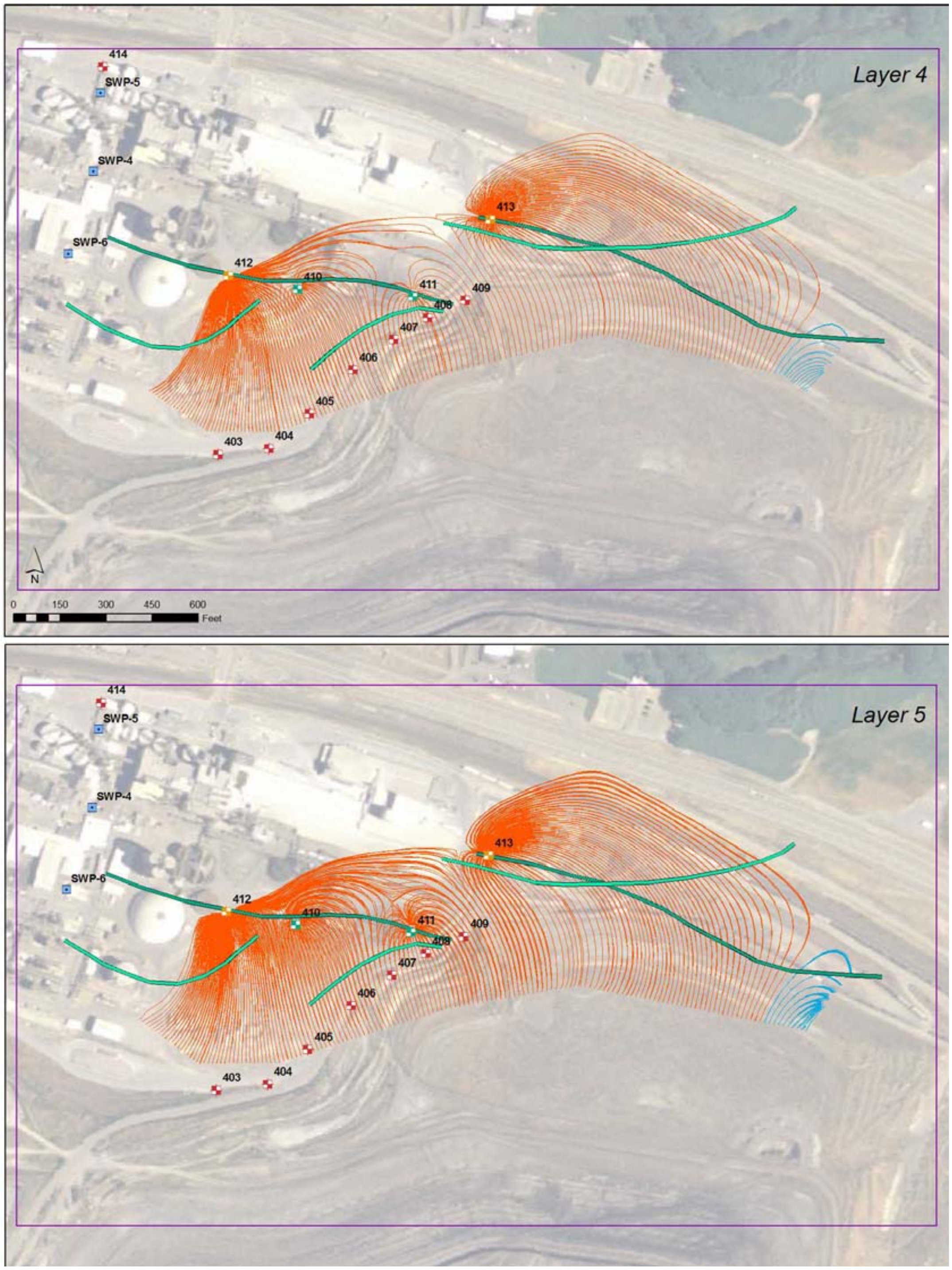


Figure 4-13: Results of particle tracking simulation in the eastern target capture zones

Central Target Capture Zone Model (Upper Zone Only)

The central target capture zone model is comprised of 4 layers, the top layer simulates the Upper Zone, layer 2 simulates the AFLB, and layers 3 and 4 simulate the Lower Zone. Layer elevations are directly input from the site hydrostratigraphic model (see Section 3-3). The lateral grid spacing is uniform at 10 feet in both the x and y directions. Constant head boundaries are provided at both the upgradient and down gradient limits of the model in layer 1 and at the bottom of model in layer 4 to provide the observed lateral and vertical hydraulic gradients. Hydraulic conductivities vary throughout the model and are based on aquifer testing results. Forward particle tracking is employed to observe the effects of pumping wells. A continuous line of simulated particles was placed at the southern edge of the modeled area. Particles were released at vertical intervals within the Upper Zone. The dense network of particles released upgradient of the pumping wells allows a visualization of well capture zones as well as areas where groundwater is not captured.

The results of particle tracking for a simulation with well 414 pumping are shown in Figure 4-14. Orange particle traces are captured by existing pumping wells; blue particle traces are not captured. The results indicate that well 414 provides a capture zone up to 400 feet in the eastern part of the zone but particles in the western part of the zone are not captured. Note that the water production well SWP-4 is not simulated in the model but that the hydraulic boundaries of the model are based on observed groundwater potential at the time that the well was pumping.

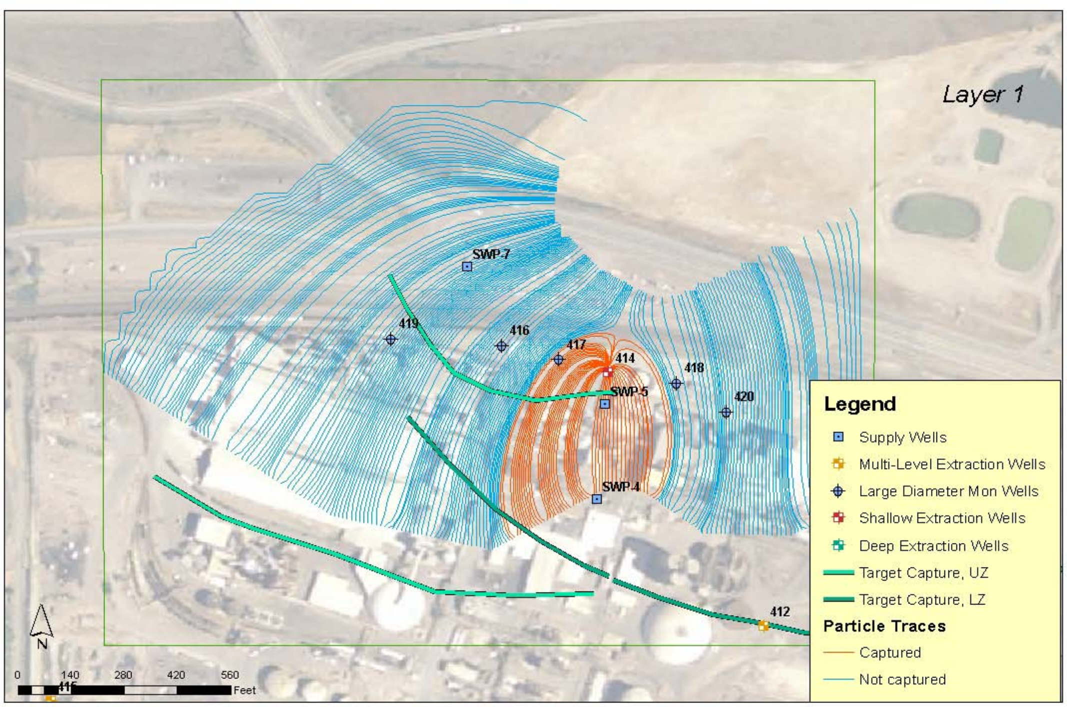


Figure 4-14: Results of particle tracking simulation in the central target capture zone

Western Target Capture Zones Model

The western target capture zones model is comprised of 5 layers, the top layer simulates the Upper Zone, layer 2 simulates the AFLB, and layer 3 simulates the Lower Zone, and Layers 4 and 5 simulate the Tertiary bedrock. Layer elevations are directly input from the site hydrostratigraphic model (see Section 3-3). The lateral grid spacing is uniform at 25 feet in both the x and y directions. Constant head boundaries are provided at both the upgradient and down gradient limits of the model in layers 1 and 3 and at the bottom of model in layer 5 to provide the observed lateral and vertical hydraulic gradients. Hydraulic conductivities vary throughout the model and are based on aquifer testing results. Forward particle tracking is employed to observe the effects of pumping wells. A continuous line of simulated particles was placed at the southern edge of the modeled area. Particles were released at vertical intervals within the Upper Zone. The dense network of particles released upgradient of the pumping wells allows a visualization of well capture zones as well as areas where groundwater is not captured.

The results of particle tracking for a simulation with well 415 pumping are shown in Figure 4-15. Orange particle traces are captured by existing pumping wells; blue particle traces are not captured. The results indicate that well 415 provides a capture zone up to 300 feet in the eastern part of the zone but particles in the western part of the zone are not captured.

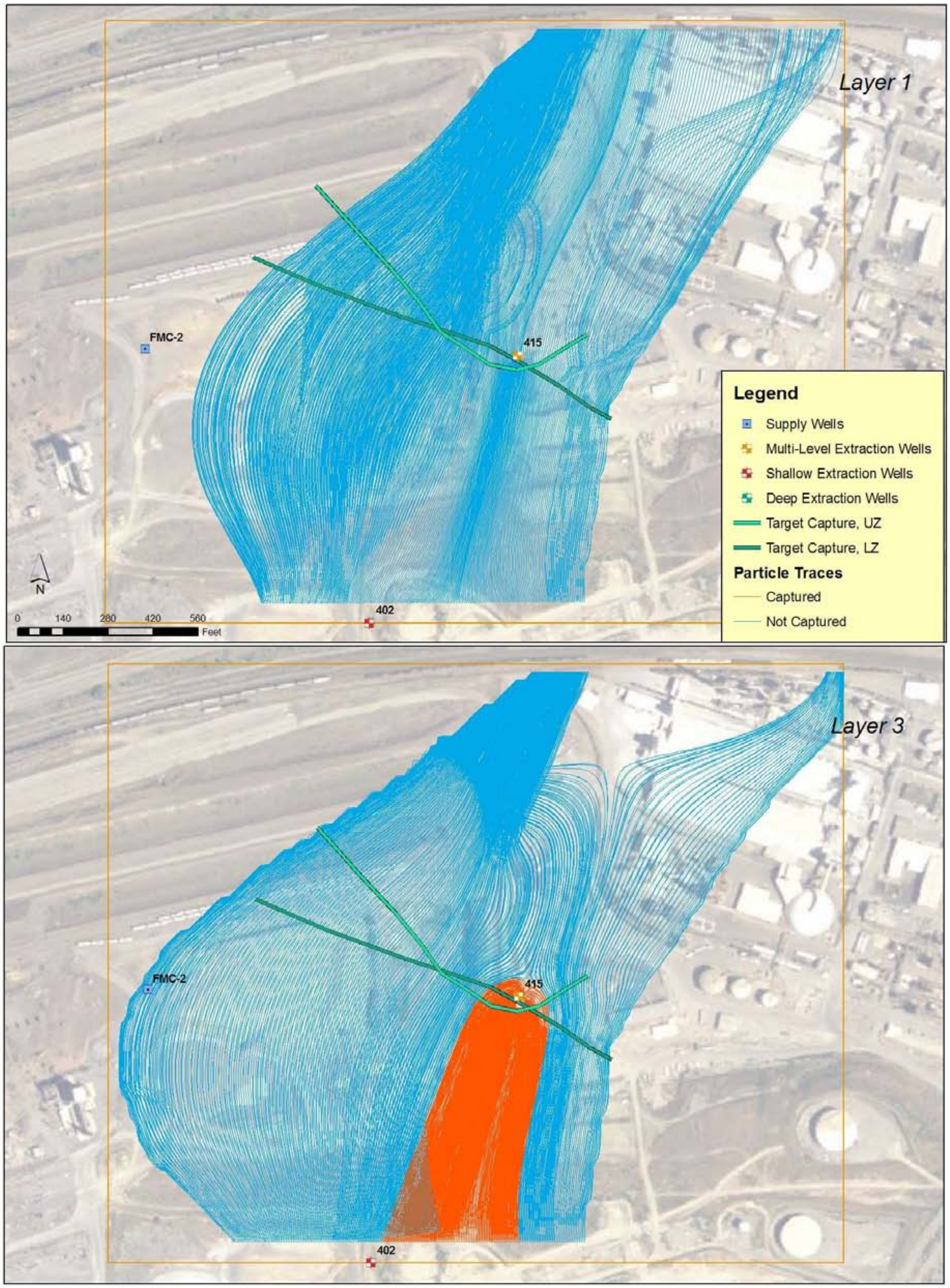


Figure 4-15: Results of particle tracking simulation in the western target capture zones

4.1.1.5 Concentration Trends of Indicator Analytes in Groundwater

The concentration trends of site-derived constituents in groundwater samples collected from monitoring wells completed down gradient of the test extraction system can be used to assess the impacts of groundwater extraction on migrating plume concentrations. The trend analyses are routinely reported in annual groundwater monitoring and extraction system reports (MFG 2005, NewFields 2006c, NewFields 2007, NewFields 2008e). In order to assess the effects of the extraction system on down gradient concentrations, the following factors must be considered:

- Down gradient monitoring wells must be positioned properly with respect to the extraction system to observe an effect.
- Down gradient monitoring wells must have a period of record that can be correlated temporally with periods of extraction.
- Groundwater travel time must be accounted for in the assessment.

The phase 1 test extraction system went into operation in June of 2004 and the phase 2 system in January of 2008. The groundwater travel time (under non-pumping conditions) from the location of wells 410 and 411 to the position of Highway 30 in the eastern plant area are estimated to be about 1 year and the travel time from Highway 30 to the spring at Batiste Road is estimated to be an additional 2.5 years. As a result, effects of pumping of the phase 1 system may be discernable in monitoring data at this time but not effects of the phase 2 system.

One possible trend that has been identified that may be related to the operation of the phase 1 test extraction system is the concentration trends in the Lower Zone well 526, which is located 875 feet down gradient of wells 410 and 411 (Figure 4-16). Concentration trends in well 526 are shown in Figure 4-17. A concentration reduction is observed in the well in late 2004. The timeframe for concentration reduction is generally consistent with groundwater travel times, estimated from aquifer properties and potentiometric surfaces, being around the order of one year or less from the extraction wells to the area of well 526. One possible cause of the reduction is that groundwater extraction has resulted in a shift of the contaminant plume to the west, and since the well was near the eastern limit of the plume, the well now monitors mostly unaffected groundwater. Concentration data collected since 2005 confirm this effect and consistently show lower concentrations than the pre-pumping data. Wells 528 and 529 were installed in 2007 to provide more information on groundwater chemistry in this area.

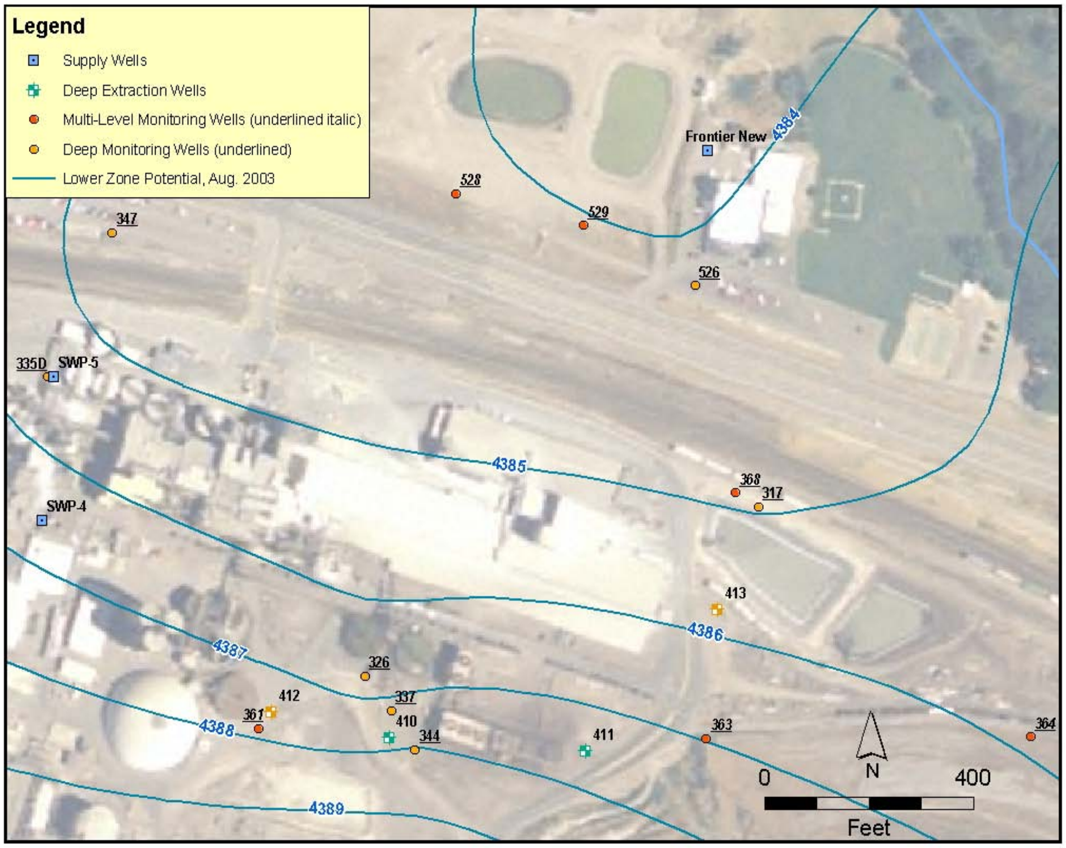


Figure 4-16: Location of monitoring wells down gradient of East Plant Area extraction wells

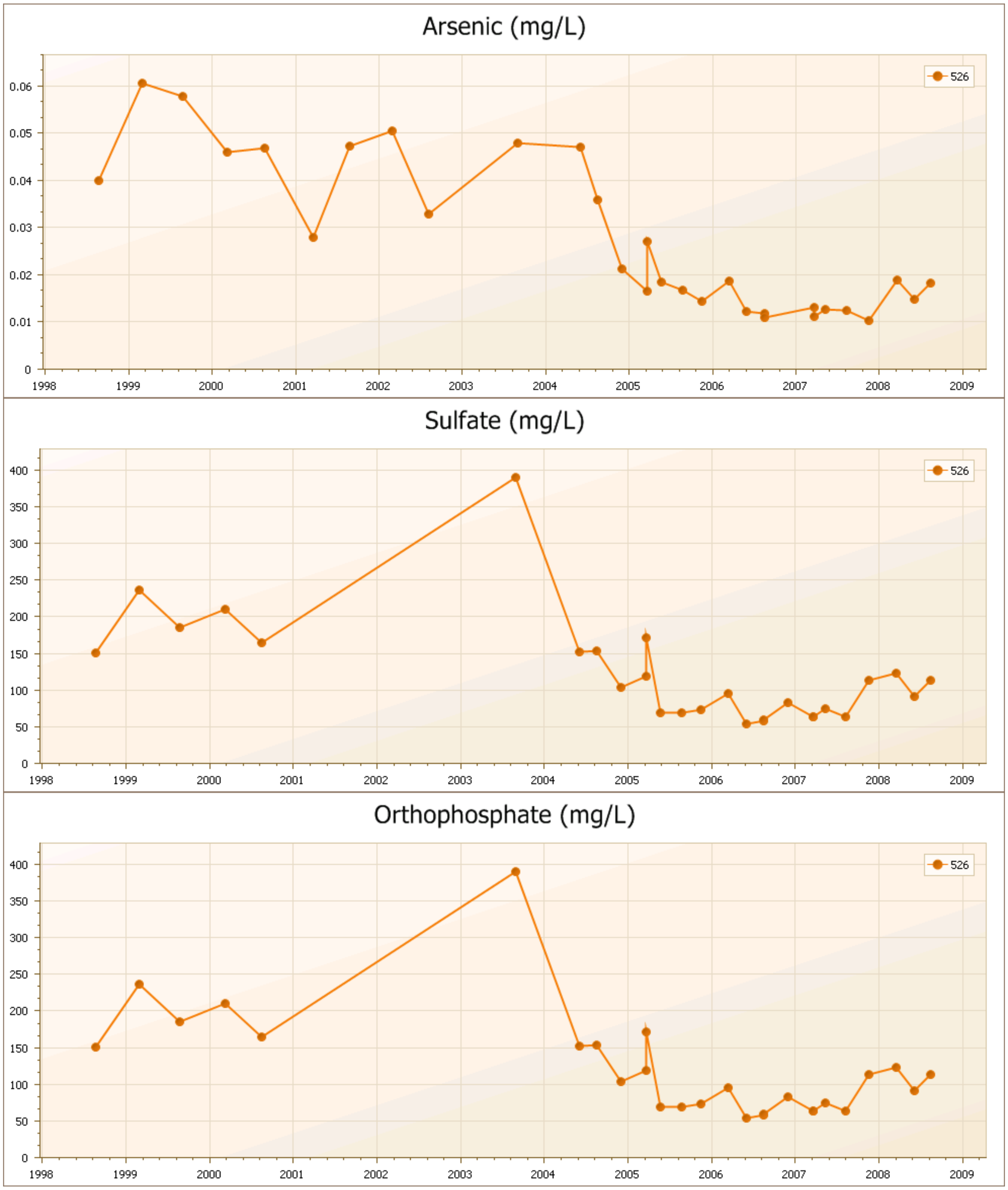


Figure 4-17: Concentration trends in Lower Zone monitoring well 526

4.1.1.6 Capture and Data Gap Assessment

The results of the analyses provided in the preceding sections can be used collectively to interpret actual capture of the test extraction system and assess the need for additional extraction as well as uncertainties and data gaps. This assessment is summarized in the following sections by target capture zone.

Upper Zones in East Plant

Analyses indicate that the current extraction in the Upper Zone in the East Plant Area not capturing all of the groundwater in the target capture zones. The inadequate performance of the shallow extraction wells 404 to 409 was realized shortly after installation and prompted the Phase 1 Data Gap Investigation (NewFields 2006a). The poor performance of these wells was found to be due mostly to the small saturated thickness of the Upper Zone where the wells are completed. The multi-level extraction wells 412 and 413, installed during the Phase 2 Data Gap Investigation (NewFields 2008a) were designed to provide extraction from the Upper Zone in this area. Capture calculations and particle tracking indicate that these wells have limited zones of capture in the Upper Zone. Reverse particle tracking of well 412 shows a capture zone slightly wider and with a stagnation point further downgradient than does the analytical calculation. Well 413 shows a much narrower capture zone in numerical models than is suggested by analytical calculations (Table 4-3). Mass flux calculations indicate that the total flow in the east plant Upper Zone target capture zones is relatively small and that the added extraction at wells 412 and 413 narrow the deficit between mass captured and mass passing the system. The well performance data and capture zone analysis indicate that full capture of groundwater in these target capture zones will require the installation of many new wells at a short spacing which may be impractical from a mass flux standpoint.

Table 4-3: Comparison of dimensions of capture zones predicted by analytical calculations and reverse particle tracking in numerical models for the Upper Zone.

Extraction Well		Approximate distance upgradient that width is measured	Analytical Calculation		Modeled	
			Width	Distance downgradient	Width	Distance downgradient
UZ	412	at 300 ft	165 ft	29 ft	243 ft	74 ft
	413	at 50 ft	600 ft	173 ft	51 ft	30 ft
	414	at 200 ft	670 ft	158 ft	420 ft	92 ft
	415	at 450 ft	215 ft	37 ft	110 ft	26 ft

This area is well characterized and no significant data gaps remain for assessment. Based on the results of the analyses it is recommended that additional extraction be provided in areas with the greatest saturated thickness. Areas that should be targeted for extraction are near well 410 and east of well 413.

Upper Zone in Central Plant

Analyses indicate that the current extraction provided by well 414 in the Upper Zone in the Central Plant Area is not capturing all of the groundwater in the target capture zone but is operating effectively. The well design is based on the results of the Phase 1 Data Gap Investigation (NewFields 2006a) and provides the most efficient extraction possible in this area. Well production is compromised by the limited saturated thickness of the Upper Zone in this area. Capture calculations and particle tracking indicate that the well has a large zone of capture in the Upper Zone. Reverse particle tracking shows a more narrow capture zone for well 414 in the upper zone than is suggested by analytical calculations (see Table 4-1). Mass flux calculations indicate that the load removal rate is insufficient for the zone since the extraction well is located to the east of higher concentration groundwater that is associated with a source that has recently been identified in the Phosphoric Acid Plant. The well performance data and capture zone analysis indicate that full capture of groundwater in this target capture zone may be achieved with the proper placement of a limited number of extraction wells.

This area will be further characterized in an investigation of the Phosphoric Acid Plant source. Based on the results of the analyses it is recommended that additional extraction be provided in the area of where the highest concentrations of constituents in groundwater have been observed, near monitoring well 340.

Upper Zone in West Plant

Analyses indicate that the current extraction provided by well 415 in the Upper Zone in the west plant target capture zone is not capturing all of the groundwater in the zone but is operating effectively. The well design is based on the results of the Phase 1 Data Gap Investigation (NewFields 2006a) and provides the most efficient extraction possible in this area. Well production is compromised by the limited saturated thickness of the Upper Zone at the location. Capture calculations and particle tracking indicate that the well has a large zone of capture in the Upper Zone. Reverse particle tracking shows a more narrow capture zone for well 415 in the upper zone than is suggested by analytical calculations (see Table 4-1). Mass flux calculations indicate that the load removal rate is sufficient for the zone since a relatively small flux of constituents is estimated not to be captured. The well performance data and capture zone analysis indicate that full capture of groundwater in this target capture zones will require the installation of many new wells at a short spacing which may be impractical from a mass flux standpoint.

Based on the results of the analyses it is recommended no additional extraction be provided in this area at this time.

Lower Zones in East Plant

Analyses indicate that the current extraction in the Lower Zone in the east plant target capture zones is removing a significant fraction but not all of the groundwater in the zones. Wells 410, 411, 412 and 413 are currently operating in this area. Capture calculations and particle tracking indicate that these wells have extensive zones of capture in the Lower Zone. Reverse particle tracing shows wider capture zones for wells 412, 413 and 415 in the lower zone than is suggested by analytical calculations (see Table 4-4). Mass flux calculations indicate that groundwater flow through this zone contributes the most mass down gradient and that the existing wells are collecting most of this mass. The recently installed multi-level extraction wells 412 and 413 benefit from a modified design and some deficiencies in extraction may be related to the design of the older wells 410 and 411. The well performance data and capture zone analysis indicate that additional groundwater extraction in these target capture zones may be obtained by replacing older wells with new wells with the modified design and selective placement of new wells.

Table 4-4: Comparison of dimensions of capture zones predicted by analytical calculations and reverse particle tracking in numerical models for the Lower Zone.

Extraction Well		Approximate distance upgradient that width is measured	Analytical Calculation		Modeled	
			Width	Distance downgradient	Width	Distance downgradient
LZ	412	at 450 ft	1000 ft	218 ft	1440 ft	800^{+} ft
	413	at 80 ft	500 ft	131 ft	250 ft	42 ft
	415	at 330 ft	360 ft	68 ft	430 ft	84 ft

This area is well characterized and no significant data gaps remain for assessment. Based on the results of the analyses it is recommended that well 410 be replaced with a new multi-level extraction well. In addition, additional extraction may be obtained by the placement of an additional well east of well 413.

4.1.2 Proposed Additional Groundwater Extraction Wells

Based on the results of the well capture analysis and the additional data acquired during the PAP Investigation, four additional extraction wells are proposed for the final groundwater extraction system. These wells will include the addition of wells 416 and 419 in the PAP Area, and two new multilevel wells in the eastern site area, tentatively identified as wells E-1 and E-2. The existing extraction system with the proposed wells is shown in Figure 4-18.

Well 416 is a new Upper Zone extraction well that is located near well 340 in the PAP Area, and is located approximately 8 feet from well 340, which has exhibited elevated concentrations of COCs. This well was designed similar to well 414 and is expected to sustain a long-term pumping rate of approximately 35 gpm.

Well 419 was recently installed as an Upper Zone extraction well during the PAP Investigation. Phosphorus concentrations in well 419 upon initial groundwater sampling were an order of magnitude greater than concentrations in any other newly installed PAP well. This location is assumed to represent a local plume of high phosphorus groundwater, and thus extraction is recommended to curtail migration of the plume. This well was designed similar to well 414 and is expected to sustain a long-term pumping rate of approximately 35 gpm.

Well E-1 is a proposed replacement well for well 410 and will be located near the exploratory boring B-410 that was drilled during the Phase 2 Data Gap Investigation (NewFields 2008a). The exploratory boring identified a potential zone of high concentration groundwater below the present screen interval in well 410. The well will be designed similar to well 412 with multiple screen intervals including an interval in the Upper Zone. The more efficient design and increased screen length is expected to result in an additional sustained yield of approximately 150 gpm from the lower zone and approximately 20 gpm from the Upper Zone.

Well E-2 is a proposed multilevel extraction well that will be placed east of well 413. Analyses indicate that additional groundwater extraction is needed in this area in both the Upper and Lower Zones. The well is expected to provide a sustained yield of approximately 80 gpm from the Lower Zone and approximately 20 gpm from the Upper Zone.

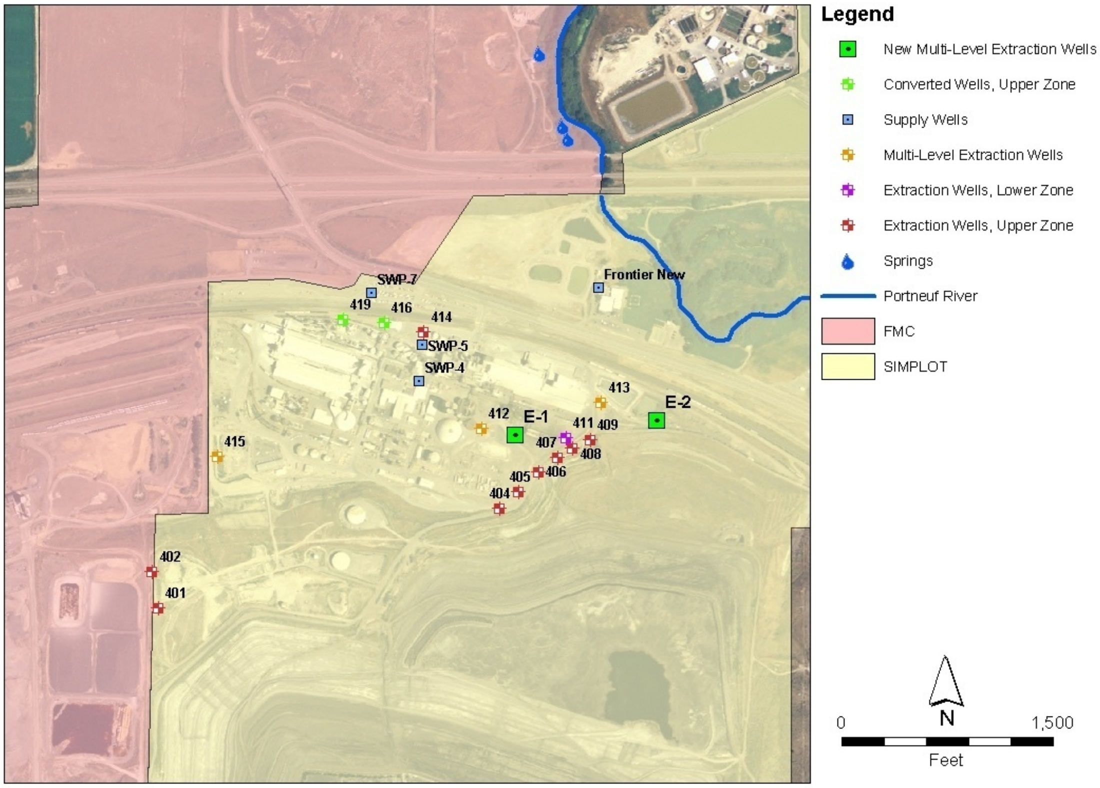


Figure 4-18: Location of existing extraction wells, monitoring wells 416 and 419 to be converted to extraction, and new multilevel wells, E-1 and E-2.

The expected effect of the new extraction wells was evaluated by revising the mass flux calculation and by performing capture analyses. The mass flux calculation was adjusted for the additional extraction at the proposed wells. Concentrations of arsenic, sulfate and orthophosphate used to calculate the load removed by the new extraction wells were estimated based on 2008 measurements at neighboring monitoring wells with similar screen depths. Well E-1 concentrations are based on concentrations observed at well 410 and well E-2 concentrations are based on concentrations observed at well 413.

The results of the mass flux calculations are provided in Appendix B. The model predicts that the addition of the three new extraction wells will reduce the arsenic concentration at the springs to meet the MCL of 0.010 mg/L, predicted average groundwater concentrations at the discharge point are as follows:

- Arsenic 0.0094 mg/L
- Sulfate 71.9 mg/L
- Orthophosphate 1.145 mg/L.

Using the expected pumping rates and hydraulic properties in the mass flux assessment, these wells were added to the existing pumping conditions in the model. Wells 416 and 419 are located in the Central Plant Area, each pumping 35 gpm from the Upper Zone. Well E-1 replaces well 410 near its location in the East area, and pumps approximately 20 gpm from the upper zone and 150 gpm from the lower zone. Well E-2 is located in the East area, and pumps approximately 20 gpm from the upper zone and 80 gpm from the lower zone. Figure 4-19 shows the modeled particle tracking for the proposed scenario.

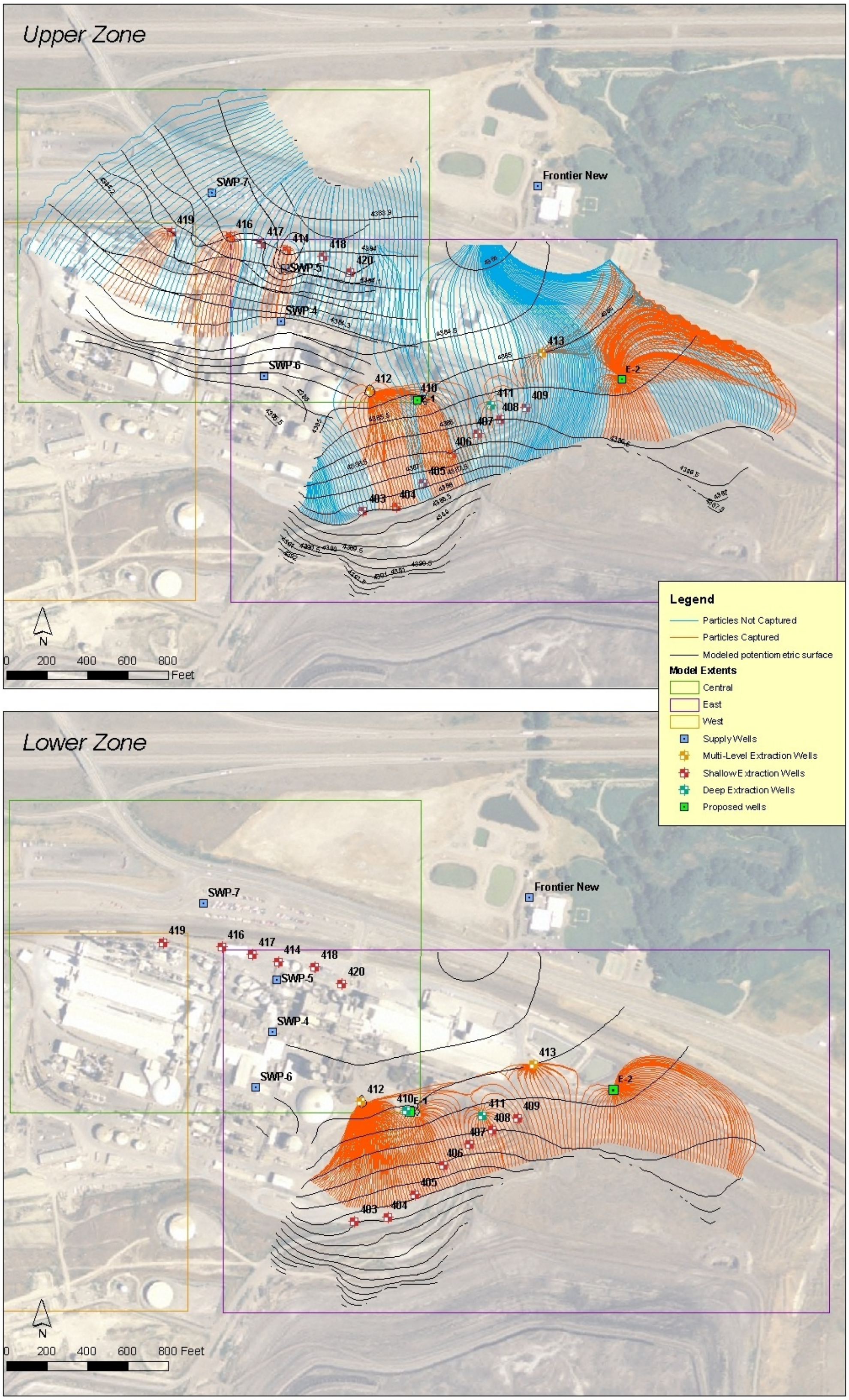


Figure 4-19: Modeled particle tracking in the Upper and Lower Zones with the addition of wells 416, 419, and the two new extraction wells E-1, and E-2.

4.1.3 Additional Extraction System Design Details

Flow and water level data are currently collected continuously for each extraction well. Flow rates are measured with electromagnetic flow meters (manufactured by Kroner). In the phase 1 test extraction system water levels in extraction wells were measured with admittance-to-current transducers, otherwise known as capacitance probes (manufactured by Drexelbrook). In August 2006, the Drexelbrook water level indicators were switched to pressure transducers (LevelTroll 500 model manufactured by InSitu). The InSitu level indicators provide more reliable pump control and more accurate water level indication. Wells installed as part of the phase 2 system were also fitted with the InSitu pressure transducers. Well pumps are fitted with a variable frequency drive (VFD) which allows the speed of the pump motor to be varied to regulate flow rate. The flow and level data are transmitted to a central control point by radio signal.

Well design issues were evaluated as part of the Phase 1 and Phase 2 Data Gap Investigations (NewFields 2006a, 2008a) and wells installed that are now part of the phase 2 system have proved to be more efficient than the phase 1 system wells. Important modifications included increasing the well diameter in deeper wells from 8 inches to 10 inches, using a larger well screen slot size, and installing well screens in selected intervals identified during drilling of pilot borings. The well installation method has been modified to provide for a pilot boring using sonic drilling methods to obtain continuous core which can be used for the evaluation of screen interval and screen slot size through the analysis of formation gradation. Well installation methods are detailed in the Remedial Action Work Plan (Formation 2009b) and include steps for field data collection, well design, and approval of the well designs by oversight agencies.

4.2 Groundwater Monitoring System

This section describes the design of the final groundwater monitoring network. Groundwater monitoring decision criteria, monitoring methods, and data evaluation methods are described in detail in the Groundwater and Surface Water Monitoring Plan (Formation 2009c). The design of the monitoring network includes an evaluation of the current monitoring system with respect to the design and performance criteria described in Section 2.

4.2.1 Evaluation of Current Groundwater Monitoring System

There are currently 137 monitoring locations included in Simplot's quarterly monitoring program. The monitoring system consists of 116 monitoring wells, 14 test extraction wells, 3 production wells, two spring locations (Batiste Spring and the Spring at Batiste Road) and 2 Portneuf River locations (at the Highway 30 bridge and at the Batiste Road bridge). Groundwater levels are measured in all the wells except for the production wells and at the river locations. Water quality samples are collected from the 14 test extraction wells, the 3 production wells the two spring locations, and 70 of the monitoring wells.

4.2.1.1 Groundwater Monitoring Areas

To facilitate the design of the modified monitoring system, the Simplot Area has been divided into a series of monitoring areas based distinct objectives for each area. The areas are shown in Figure 4-20. These zones are as follows:

- Don Plant Area
- Target Capture Overlay (in Don Plant Area)
- Assessment Area
- Compliance Area

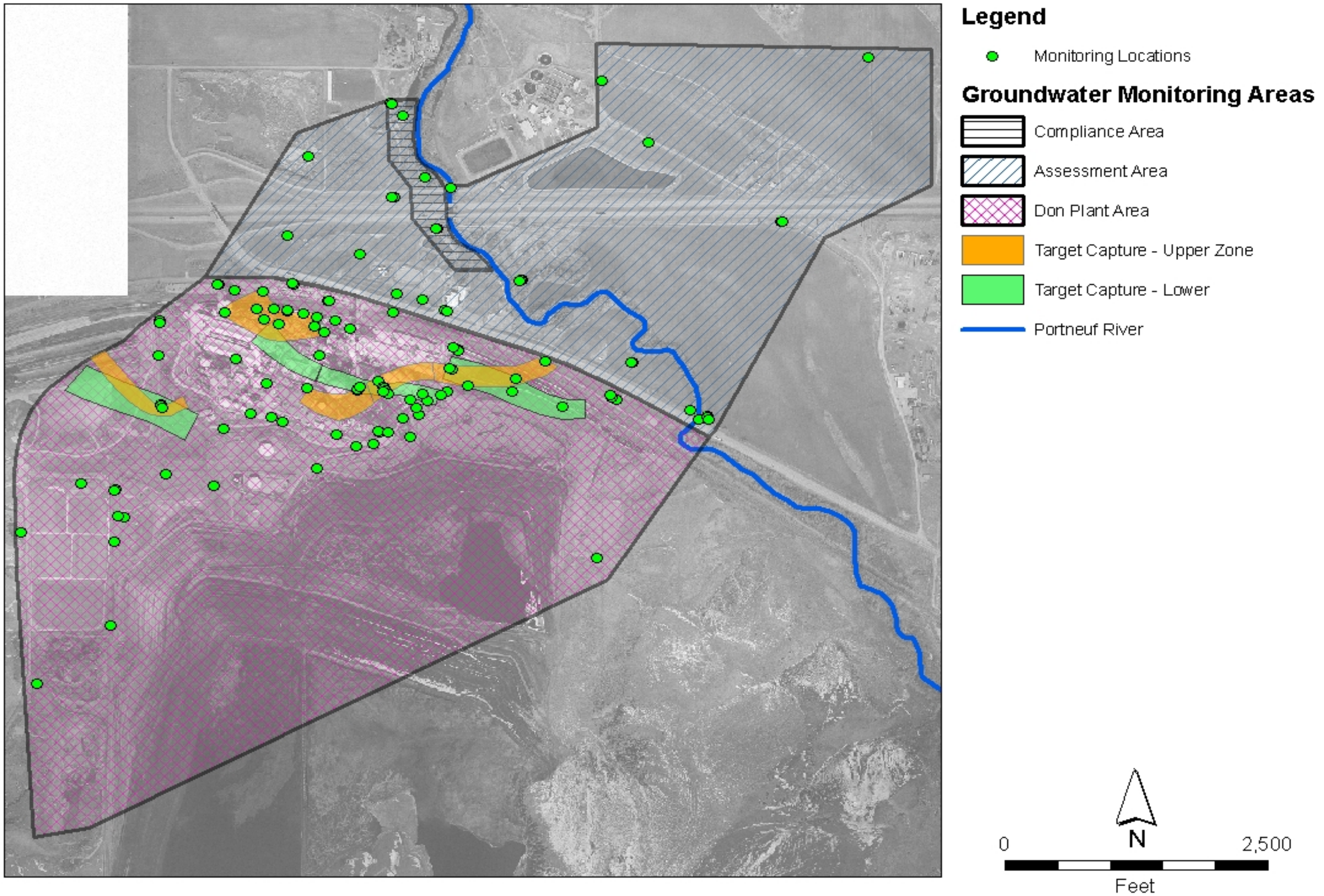


Figure 4-20: Location of monitoring areas within the Simplot Area

The Don Plant Area includes potential source areas, areas immediately down gradient of potential source areas, and the target capture zones. The monitoring well network in this area needs to provide groundwater quality data that can be used to track constituent concentration trends, evaluate the migration of and concentrations of constituents in groundwater to the target capture zones, and assess the adequacy of the target capture zones. The network also needs to provide water level data at a sufficient scale so that groundwater gradients and flow paths can be evaluated.

The target capture zones are an overlay area on the Don Plant Area which include additional monitoring requirements. Data collection needs in these zones also include tracking groundwater flow rate in extraction wells, tracking water levels in extraction wells, tracking water levels in nearby monitoring wells to assess extraction well capture.

The Assessment Area is the area that is down gradient of the groundwater extraction system and extends to the compliance area. The groundwater monitoring network in this area needs to be of sufficient lateral and vertical spacing to delineate the plume of groundwater affected by Simplot operations. Water quality and water level data will be collected from the network of wells to confirm the position of the plume, assess trends in water quality, and assess groundwater gradient and flow paths. In addition, a subset of monitoring wells in the upgradient portion of this area will be used to provide an interim target concentration that can be compared to the concentrations in the Compliance Area.

The Compliance Area is the area where groundwater concentrations will be measured and compared against applicable water quality standards. Similar to the Assessment Area, monitoring wells need to be placed at adequate lateral and vertical spacing to delineate the position of the plume of affected groundwater prior to discharge to the Porteneuf River.

4.2.1.2 Gaps in the Existing Monitoring Network

The current CSM for groundwater, summarized in Section 3.3, provides the basis for evaluating the adequacy of the current monitoring well network. The following conclusions can be made for each area:

Don Plant Area – The monitoring well network in this area is adequate to meet the data objectives.

Target Capture Zones – The existing well network is adequate to meet the data objectives for water quality monitoring but the network will need to be expanded to provide for additional water level monitoring. Additional water level monitoring will need to be provided near new extraction wells to assess the capture zones of the new wells and provide for the adequate assessment of the hydraulic properties of the strata from which groundwater is being extracted.

Assessment Area – The current monitoring well network was used in conjunction with the results of the groundwater geophysical investigation to evaluate the approximate lateral and vertical extent of affected groundwater in this area. However, additional monitoring wells are necessary to confirm the position of the plume and to provide for long-term monitoring. Additional wells are also needed in the upgradient portion of this area for the assessment of the interim target concentration.

Compliance Area – There are currently two monitoring well nests located in this area. The well nest 524/525 is effective in monitoring unaffected groundwater north of the plume at the Portneuf River. The well nest 504/505 appears to be located within the zone of affected groundwater near the southern limit of the plume at the river. Additional monitoring wells are needed within the core of the plume at the river and in unaffected groundwater south of the plume at the river.

4.2.2 Additional Monitoring Wells

Based on the modifications proposed for the extraction system (Section 4.1) and the data gap assessment presented in the previous section thirteen additional monitoring well nests will be installed. The preliminary locations of these wells are shown in Figure 4-21 (designated wells M-1 through M-13).

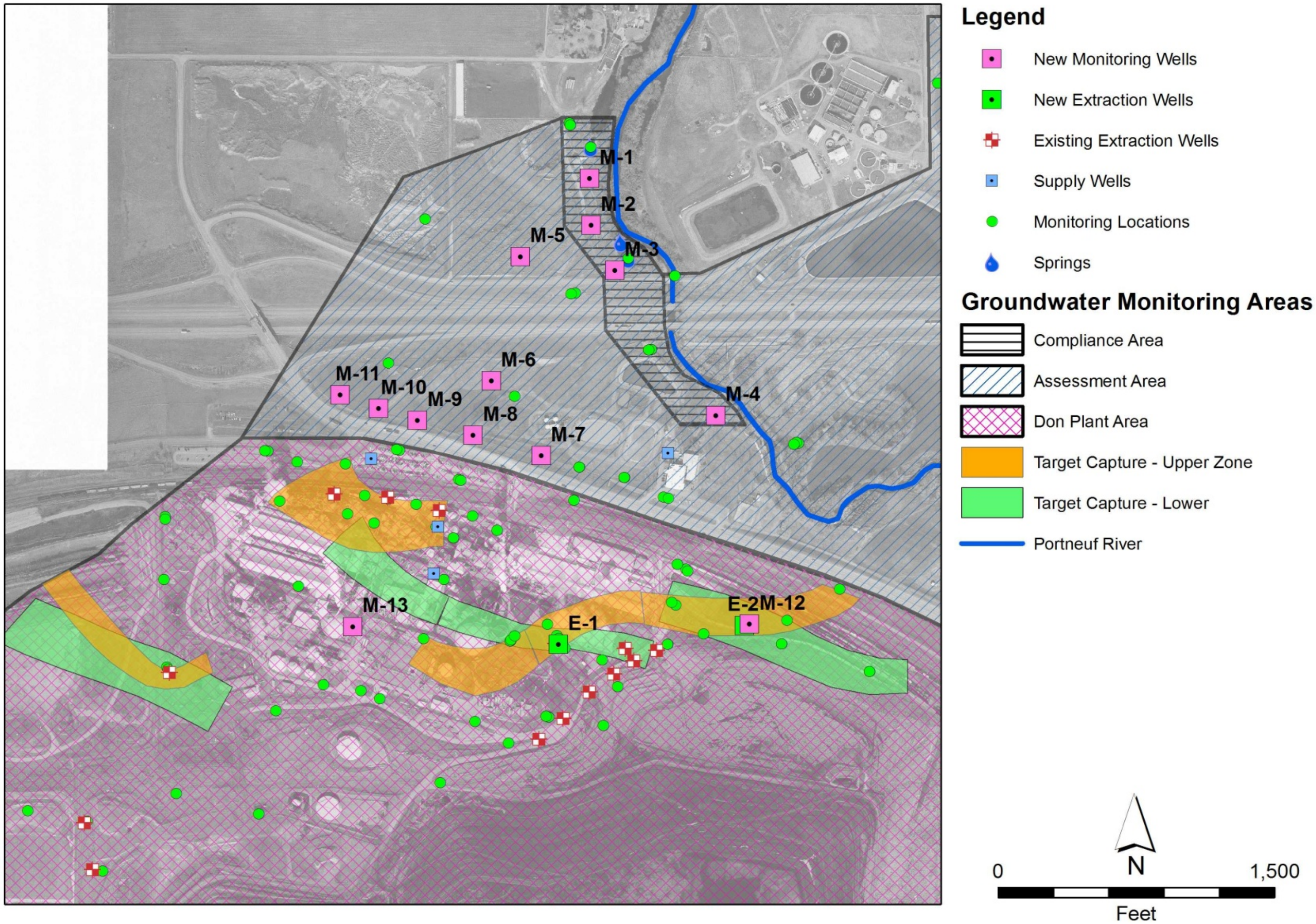


Figure 4-21: Proposed locations of additional monitoring wells.

The purpose of the proposed monitoring wells is as follows:

- Monitoring wells M-1, M-2, and M-3 will be nested wells consisting of at least two separate screen intervals each. These locations will be used to confirm plume position and provide water quality data to demonstrate compliance.

- Monitoring well M-4 will be a nested well consisting of at least two separate screen intervals. This location will be used to confirm the southern limit of the plume prior to discharge to the Portneuf River in a similar manner that the well nest 524/525 confirms the northern limit of the plume.

- Monitoring wells M-5 to M-11 will be nested wells consisting of at least two separate screened intervals each. These locations will be used to confirm plume position, measure hydraulic gradients, and track trends in water quality.

- Screen intervals within the plume in monitoring wells M-7, M-8, M-9, M-10, and M-11 will be used in conjunction with the existing well nests 528, 529 and 526/529 to evaluate interim target concentrations.

- Monitoring well M-12 will be a shallow monitoring well that will be used for water level monitoring near the new extraction well E-2. Existing monitoring wells near the new extraction well E-1 will be used for this purpose.

- Monitoring well M-13 will be a nested well with all intervals completed within the Lower Zone and will be completed next to the Upper Zone monitoring well 341. These locations will be used to confirm plume position, measure hydraulic gradients, and track trends in water quality in the Lower Zone upgradient of well SWP-4.

4.2.3 Method for Establishing Interim Target Concentrations and Demonstrating Compliance

Groundwater monitoring data collection and evaluation methods are described in detail in the Groundwater and Surface Water Monitoring Plan (Formation 2009c). A summary of the methodology is provided in the following paragraphs so that the adequacy of the monitoring well network that will be used to collect the data can be evaluated.

4.2.3.1 Establishing Interim Target Concentrations

An interim target concentration will be established for groundwater in the southern portion of the Assessment Area, downgradient of all site sources in a line just north of Highway 30, to provide an additional means for identifying conditions that may result in applicable standards being exceeded at the point of compliance (POC). The term 'interim' is applied in both a spatial and temporal context. The locations of the interim target monitoring wells will be spatially up gradient from POC and concentrations observed at these locations may be indicative of future conditions at the POC (accounting for groundwater travel time). The most effective use of the interim target concentration will be after the period where source controls have taken affect and groundwater concentrations in the Assessment Area have stabilized. At this point, the interim target concentration should be able to provide an early indication of a potential exceedance at the POC. Concepts for the development of the interim target concentration are discussed in the following paragraphs.

A relationship between the average plume concentration at the POC and in the southern portion of the Assessment Area must be established. It is reasonable to expect that the interim target concentration will be higher than the average groundwater concentration at the POC to account for dilution and attenuation processes. The relationship between the interim target concentration and the compliance concentration can be expressed mathematically as follows:

$$C_{IT} = C_{POC} \text{ x DAF}$$

where:

C_{IT} = average concentration at interim target well locations

C_{POC}= average concentration in compliance area

DAF= dilution and attenuation factor

Both the concentration in the compliance area (C_{POC}) and the interim target concentration (C_{IT}) are applicable to the average *affected* groundwater concentration. Monitoring wells in each area must be able to delineate the lateral and vertical extent of the affected groundwater and provide representative water quality samples of the affected groundwater. These monitoring objectives will be accomplished through groundwater sampling and water level measurement in the Assessment Area at the new nested wells M-7, M-8, M-9, M-10, M-11 and the existing well nests 528, 529 and 526/527, and in the compliance area at the new nested wells M-1, M-2 and M-3. The concentration C_{IT} and C_{POC} will be calculated as the average concentration in groundwater samples collected from the screen interval in these wells that is shown to be within the plume of affected groundwater. The DAF can then be calculated as follows:

$$\text{DAF} = C_{IT} / C_{POC}$$

The DAF will be calculated continuously as monitoring data are collected. The DAF is expected to change as the concentrations in the downgradient monitoring wells change due to the implementation of the extraction system. Since the groundwater travel time from the upgradient assessment wells to the point of compliance is currently estimated to be 2 to 3 years, a differential effect on groundwater concentrations in the two areas is likely to be observed – initial effects in the assessment wells may be observed within the first year of the initiation of extraction but not for over 3 years at the point of compliance.

Two conditions must be satisfied before C_{IT} is used as an action level:

- Groundwater concentrations in the compliance area must meet applicable standards (see next section).
- Enough data must be obtained to provide for an adequate assessment of the concentration trends in monitoring wells used in the compliance and assessment areas and determine the effect of travel time on DAF calculations.

Once established, the C_{IT} will be used for early identification of potential changes in conditions upgradient.

4.2.3.2 Demonstrating Compliance

To demonstrate compliance with groundwater standards such as a MCL, the 95% upper confidence limit (UCL) on the mean of the concentration in groundwater samples from all well screen intervals within the compliance area will be calculated and compared on an interval by interval basis. A minimum of eight values from each interval are required to perform the analysis.

To make a comparison to groundwater goals that are based on surface water quality criteria such as TMDL goals, the discharge load of the constituent from the groundwater system to the Portneuf River is the primary consideration. The load value can be converted to an average concentration of affected groundwater (C_{POC}) in the compliance area by considering the discharge rates of both the groundwater and the river. The discharge rate of affected groundwater in the Compliance Area is a function of the hydraulic conductivity, hydraulic gradient, and cross-sectional flow area of the zone of affected groundwater.

Monitoring wells in the compliance area must be able to delineate the lateral and vertical extent of the affected groundwater and provide representative water quality samples of the affected groundwater. These monitoring objectives will be accomplished through groundwater sampling and water level measurement in the compliance area at the new nested wells M-1, M-2, and M-3. In addition, water quality data from Batiste Spring and the Batiste Road Spring are also available.

4.2.4 Monitoring Well Installation Considerations

Well installation methods are detailed in the Remedial Action Work Plan (Formation 2009b). Monitoring wells will be installed using sonic drilling methods to provide for continuous borehole core collection. Vertical profiling methods will be used to assess groundwater quality during drilling, and locations may need to be field adjusted based on these results. Well screen intervals will be selected during drilling and will require the active participation of the oversight agencies.

5.0 CONSTRUCTION MANAGEMENT AND CONSTRUCTION QUALITY ASSURANCE

This section presents an overview of the construction inspection and management procedures including a brief discussion of project roles and responsibilities.

5.1 Management of Remedial Construction

The project participants involved in the remedial construction are indicated on the project organizational chart shown in Figure 5-1. The roles and responsibilities of these individuals are summarized below.

EPA Remedial Project Manager (RPM) – The EPA RPM will be responsible for regulatory oversight of the remedial construction. She will communicate directly with the Simplot Remedial Action Coordinator to verify that the remedy is successfully implemented. Ms. Kira Lynch is the EPA RPM.

IDEQ Project Manager (PM) – The IDEQ PM will be responsible for the oversight of the remedial construction and compliance with the VCO/CA. She will communicate directly with the Simplot Remedial Action Coordinator to verify that the remedy is successfully implemented. Ms. Margie English is the IDEQ PM.

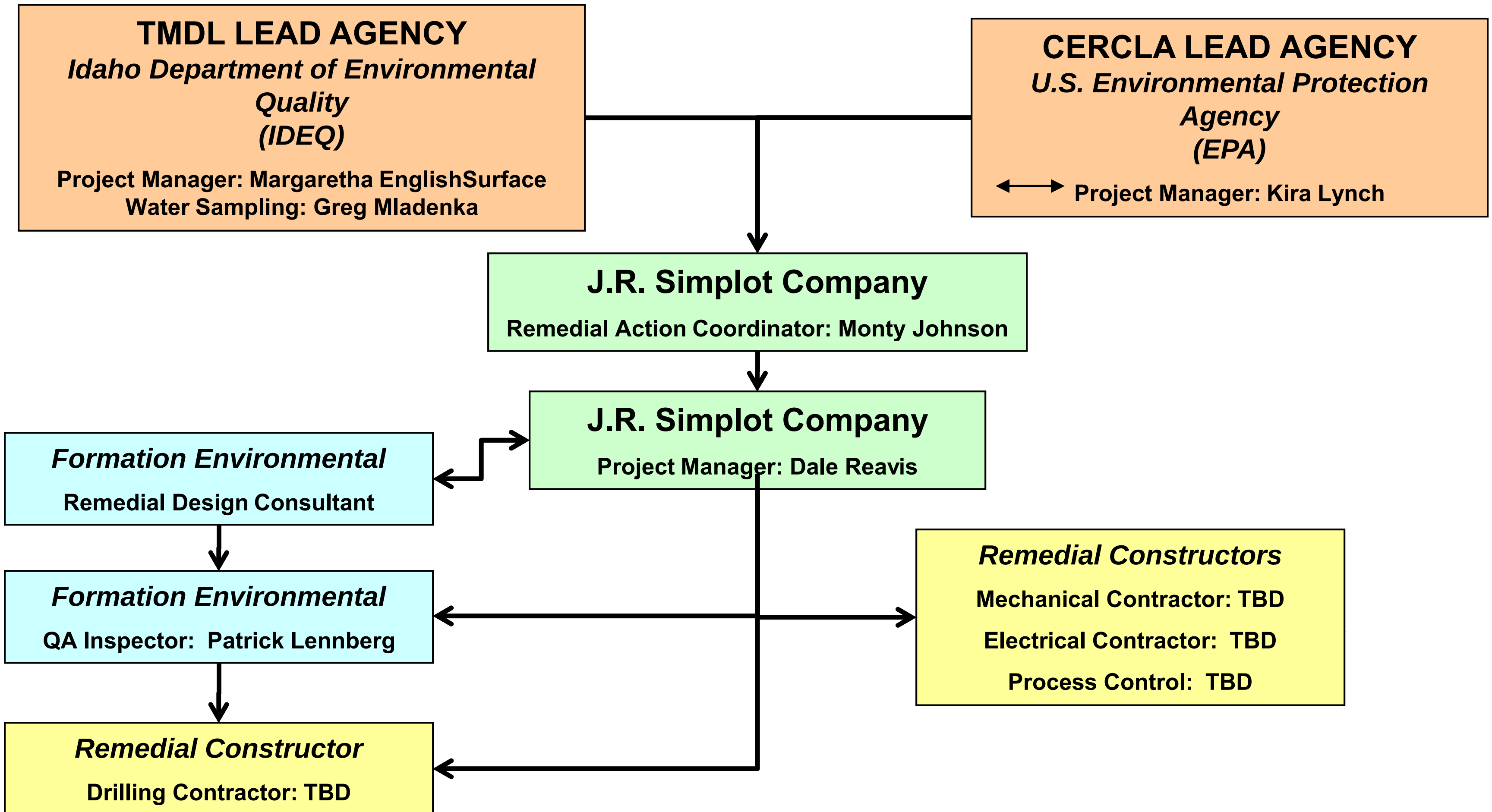
Simplot Remedial Action Coordinator (RAC) – The Simplot RAC will have overall responsibility for the project. He will communicate directly with the EPA RPM and the Simplot Site Manager to ensure the construction is performed in accordance with the project plan. Mr. Monty Johnson is the Simplot RAC.

Simplot Project Manager (PM) – The Simplot PM will be the local contact for the Company. He will be responsible for contracting the work and managing the remedial design engineers and constructors during all phases of project implementation. He will communicate with the Simplot RAC, the remedial constructors, and the QA Inspector. Mr. Dale Reavis, P.E. is the Simplot PM.

Quality Assurance (QA) Inspector – The QA Inspector will provide oversight during extraction well construction to ensure that the wells are installed in accordance with the plan. He will support the Simplot PM during the well construction phase of the project and will communicate directly with the Simplot PM and the well installation contractor. Mr. Patrick Lennberg, with Formation Environmental, is the QA Inspector.

Remedial Design Engineers and Constructors – Remedial design and construction may be performed by outside contractors. Formation Environmental provides remedial design support. Yet to be determined outside contractors will complete the extraction wells and install pumps, electrical equipment, process control components, buried conveyance piping and associated improvements. The well construction contractor will communicate directly with the QA Inspector while the other contractors will communicate directly with the Simplot PM. Qualified contractors will be selected to drill and install wells, install the pumps, conveyance piping, electrical equipment, process equipment and other associated improvements.

Although no significant changes are envisioned, material changes to the scope of work or procedures for implementing the construction may be necessitated by currently unforeseen conditions. If this occurs, change in management procedures will be initiated to facilitate the modification and gain EPA approval. Proposed or necessitated changes will be presented in writing to the EPA for review and approval. This change request will identify: the problem or situation that the change arose from; describe in detail the recommended change or modification suggested as a solution; and present an evaluation of the impact to the attainment of performance standards or schedule, if any. No deviations from the plan will proceed without approval of the EPA. However, minor changes in the sequencing, well layout, or procedures not in conflict with the intent of the plan will be documented by the on-site representative and reported to the EPA's project manager, but will not require the initiation of formal change management procedures.



Groundwater Remedial Design
SIMPLOT EMF

FIGURE 5-1
Project Organizational Chart

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FORMATION ENVIRONMENTAL

5.2 Quality Control and Quality Assurance

This section describes the general quality control and quality assurance procedures to be implemented by the construction management team to ensure compliance with the project requirements. Quality control refers to the procedures, methods and tests utilized by the remedial constructors to achieve compliance with the project plan. Quality assurance refers to the site inspection, checks and tests performed by the management team to ensure that the substantive requirements of the project plan are met.

The primary quality control procedures to be utilized by the remedial constructors include the use of adequately skilled personnel for the work being performed. The constructors will be required to submit information on all materials used for construction (i.e., well materials, filter pack, pumps, piping, flow controls, and instrumentation) to confirm that the project materials requirements are met. In addition, the remedial constructors will be required to cooperate with the Simplot SM and the QA Inspector in performing inspections and other quality assurance activities.

Quality Assurance procedures will primarily involve field inspections of the construction by the Simplot SM and the QA Inspector. All procedures, materials, and equipment used in the construction will be observed and monitored by the SM and QA Inspector on a daily basis. The QA Inspector will verify that all wells are constructed in the location and to the depth specified in the project plan. The SM will verify that all of the piping, flow control and instrumentation are installed as required and in accordance with the project plan. System startup testing will be performed following construction in order to demonstrate that the system components have been installed and are functioning properly. The startup testing will include testing of the system controls to verify proper operation under the full range of field conditions. At this time, performance testing of the pumps will be performed to demonstrate that the pumps are properly sized for the actual yield of the water-bearing zone.

Work elements that are found not in compliance with the project plan will be modified or replaced so that the element is in compliance. All material submittals and quality control data supplied by the constructors will be documented by the SM and QA Inspector to allow complete project tracking of all components of the construction.

5.3 Constructi on Reporting

The Simplot SM and QA Inspector are responsible for overseeing the construction activities. The QA Inspector will keep a daily log, or complete a daily report, documenting the following information:

- Date

- Weather conditions
- Start and stop times
- Names of people working and tasks performed by each
- Work locations and quantities of materials placed
- Location and results of all quality control tests
- Any other item the field supervisor feels is appropriate to include in the log

In accordance with the requirements of the Consent Decree and Statement of Work, monthly progress reports will be submitted to the EPA to provide a status of activities being conducted within the Simplot Plant Area. A section of this report will be dedicated to reporting on the progress of groundwater extraction system construction, as appropriate.

Upon substantial completion of the groundwater extraction system construction activities, the EPA will be notified for the purpose of conducting a Prefinal Construction Inspection, which will consist of a walk-through inspection. If outstanding construction items are discovered during the inspection, a Prefinal Construction Inspection Report will be submitted, including details of outstanding construction items, actions performed to resolve the items, completion date and an anticipated date for the final inspection. The final construction inspection will evaluate items identified in the prefinal inspection. Within 30 days of the Final Construction Inspection, a Construction Completion Report will be submitted. This report will include descriptions of the remedial activities, field records and as-built drawings. This report will include a description of the project organization, the construction sequence, equipment and personnel used during remedial activities, a description of design changes/field changes/change orders, a summary of all QA/QC testing, surveying and final project quantities.

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6.0 OPERATI ONS AND MAINTENANCE

This section describes the operation and maintenance activities associated with the groundwater extraction system. As discussed in Section 4, the final extraction system will consist of a network of 18 extraction wells piped to the plant cooling towers. Each well will be equipped with a submersible pump, flow meter, pressure gauge, water level elevation monitor, and associated valves and controls. Process control telemetry will be used to relay the pump flow rate and water level elevation from each well back to a central control area. In addition, all above ground piping components at each wellhead will be heat traced for freeze protection.

In general, maintenance requirements for the system will be limited as the major system components (pumps, flow meters, pressure gauges and sensors, etc.) are designed by the manufacturer to be maintenance free. Operations requirements will also be limited as the extraction system is intended to normally operate within the guidelines established for the system with only limited adjustment.

A detailed O&M manual for the system has been prepared and was submitted to EPA under separate cover (Formation 2009a). The primary O&M requirements described in the manual are summarized below.

6.1 Equipment Startup and Operator Training

Operation of the system will be relatively straightforward and will not require detailed operation specifications or extensive operator training. Following system startup, the system will be ready for normal operations. The Simplot site manager (SM) will oversee the system startup and during this period will instruct the system operators in the proper procedures for system start-up from the central control area. New operators will be trained in system operation before they will be allowed to control the system. Training for the extraction system will be incorporated into the standard Ore Receiving/Water Reclaim training regularly conducted by the Don Plant training department.

6.2 Normal Operation and Maintenance

The operational goals have been selected to maximize the amount of groundwater extracted without causing dewatering of the well and overheating of the extraction pump. These wells are equipped with variable frequency drives that throttle the pumping rate as necessary to maintain the target water level or flow rate. Performance of the system will be assessed by monitoring and the goals and will be modified as necessary.

Routine maintenance functions will consist of performing maintenance checks of the system components according to the manufacturer’s guidelines as specified in the system O&M

manual. However, as noted previously, the majority of the system components are designed to be maintenance free and these maintenance requirements will be limited. As necessary, equipment maintenance and repair functions will be performed either by Simplot Don Plant personnel or outside contractors.

6.3 Routine Monitoring and Laboratory Testing

Requirements for routine monitoring and laboratory testing of groundwater to assess system performance are described in the Groundwater and Surface Water Monitoring Plan (Formation 2009c).

6.4 Health and Safety Plan

Worker safety and protection during system operation and maintenance activities will be governed by the Site Health & Safety Plan (Simplot Plant Area EMF Superfund Site Health & Safety Plan for Fieldwork in Support of Remedial Design, August 2002) and associated addenda dated November 1, 2002 and April 30, 2003, as well as the standard Don Plant Health and Safety procedures.

6.5 Records and Reporting

Daily operational logs will not be required as operational data for the system will be gathered by a process monitoring computer program, Process Explorer. These data will be managed in electronic format and can be compiled and configured as required by the operator. It is anticipated that the system will track the average daily flow rates and water levels for each well. Records of repairs and/or replacement of individual system components will be generated by the system operator and maintained at the central control area, as appropriate.

Monitoring of water levels and water quality in the extraction wells and the surrounding monitoring wells will be conducted on a quarterly basis to support evaluation of system performance. Details of this monitoring program, including sampling procedures and frequencies, are provided in the Groundwater and Surface Water Monitoring Plan (Formation 2009c).

In accordance with the requirements of the SOW, monthly progress reports will be submitted to the EPA to provide a status of activities being conducted within the Simplot Plant Area. A section of this report will be dedicated to reporting on the progress of the groundwater extractions system operation activities, as appropriate. In addition, monthly water flows will be reported for 1) the extraction wells, 2) the production wells, 3) fresh water input to the phosphoric acid plant, 4) water sent to the gypsum stack, and 5) water returned from the gypsum stack to the process.

If necessary, system emergencies will be reported to the operations personnel in the central control area so that appropriate corrective actions can be implemented. System errors and corrective actions will then be reported to the Simplot SM and the Simplot remedial action coordinator (RAC). System errors and corrective actions will generally be reported to EPA via the monthly progress reports unless earlier reporting is deemed necessary by the Simplot RAC.

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APPENDIX A

Simplot Water Flow Data and Calculations

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SIMPLOT COMMUNICATION

P.O. Box 912, Pocatello, ID 83204

AGRIBUSINESS

To: Alan Prouty, JR Simplot Regulatory Affairs
Ward Wolleson, JR Simplot Regulatory Affairs

October 14, 2004

From: Howard Skidmore, Process Engineer

Subject: Description of Gypsum Stack Water Balance Calculations & Assumptions

The following is a description of calculations and assumptions used to perform a water mass balance on the JR Simplot Company Gypsum Stack system. Values are based on averages from January 2002 through September 2004.

Figure 1 below is the basis values for the calculations, which are in Figure 2.

Total Gyp Flow based on Gyp Banks gpm	Ave Total Gyp Flow based on Gyp Banks ton/min	Ave Dry Gyp Flow Total Solids ton/min	Ave Water Flow Total Mass ton/min	Calculated Water Flow Average gpm	Decant Return Water to PAP Ave Flow gpm
3,834	20.0	5.6	14.4	3,462	759

Notes & Assumptions: Figure 1. Gypsum Stack Water Balance Basis Values

Item	Description
Total Gyp Flow based on Gyp Banks	Monthly average flow (gpm) based on the sum of all three gypsum bank (East, West, and Spare) flow meters. During normal operation, two or three banks are in service, depending on need. The flow is generated from the Process Explorer data acquisition system.
Average Total Gyp Flow based on Gyp Banks	From the flow generated above, the mass flow is calculated using a constant 1.25 Specific Gravity factor for simplicity.
Average Dry Gyp Flow Total Solids	The dry gypsum mass quantity based on gypsum thickener underflow solids density measurement (on-line instrument) and gypsum thickener underflow rates. The total gypsum mass is calculated from the flows coming from both the East and West Gypsum Thickener. The data is generated from the Process Explorer data acquisition system. A constant 1.30 Specific Gravity factor is used for simplicity.
Average Water Flow Total Mass	This is the difference between (average total gyp flow based on gyp banks) and (average dry gyp flow totals solids). This is the total water value used in the balance calculations for water (see figure 2).
Calculated Water Flow Average	The volumetric flow of water (gpm) based on the average water flow total mass, using a constant 1.00 Specific Gravity factor.
Decant Return Water to the PAP Average Flow	Flow generated from the Process Explorer data acquisition system. This is an average flow (gpm) based on flow meter readings.

The following analysis defines the estimations used to perform a material water balance on the JR Simplot Company, Don Plant, Gypsum Stack System. This analysis below deals only with the water portion of the flow going to and returning from the gypsum stack. The portion of the overall balance dealing with the solids has been removed from this analysis.

		Temperature Range 120 F to 50 F 0T (F) 70	Daily Evaporation Rate 0.25 in Pond Area 60 Acr	Daily Evaporation Rate 0.25 in Damp Area 200 Acr	Total Gypsum Stack Area 0Π□ Acres
A. Decant Return Water to PAP Ave Flow ton/min	**B.** Gypsum Residual Moisture Content 20% ton/min	**C.** Gypsum Flow Cooling Evaporation ton/min	**D.** Gypsum Stack Pond Evaporation ton/min	**E.** Damp Gypsum Stack Evaporation ton/min	**F.** Percolation Water ton/min
3.2	1.4	1.0	1.2	3.9	3.7

Notes & Assumptions: 2. Gypsum Stack Water Balance -- Mass Basis

Stream	Item	Description
A	Decant Water Return	Flow generated from the Process Explorer data acquisition system. This is an average flow (gpm) based on flow meter readings.
B	Gypsum Residual Moisture Content	Water content of gypsum after it initially falls from the gypsum stack supply line. The balance of water flows to the pond area. The quantity of water for the calculations is set by the constant factor, assumed in Figure 2 as 20% in column B.
C	Gypsum Stream Cooling	Water evaporation associated with cooling the gypsum bulk stream from operating temperature to estimated ambient water temperature. This quantity of energy removed is based on the gypsum stream flow rate. Equation: $\mathbf{Q = (m*Cp*\Delta T)_{gypsum} = (m\lambda)_{water}}$ Operating temperature difference (**ΔT**) is defined in column C at 70 ^{o}F. The heat capacity (**Cp**) is based on 0.2723 Btu/# F for 100% gypsum dihydrate ($CaSO4 * 2\ H2O$), and 1 Btu/# F for water. The heat capacity of the gypsum is from Perry's Chemical Engineering Handbook, 6th Edition. At 30% gypsum solids & 70% water, the calculated quantity is estimated at 0.78 Btu/# F for the mixture. A factor of **0.75 Btu/# F** is used for calculations. Water vaporization, λ, is estimated at **1,000 Btu/#** for simplicity.
D	Gypsum Pond Evaporation	Evaporation associated with the pond of water on the gypsum stack. The pond area is an estimate based on the total surface area of the gypsum stack. This pond area can change over the year, but for calculation simplicity, it is assumed constant.
E	Damp Gypsum Stack Evaporation	Evaporation of water associated with the residual water contained with the gypsum. The damp section of the stack will allow water to continue to evaporate. This wetted area is estimated based on the total gypsum stack area and is assumed constant for calculation simplicity. The evaporation rate is estimated as the same as the pond evaporation (D).

F	Gypsum Stack Percolation Water	Water assumed percolating through the gypsum stack. This is the balance of water that is not accounted in the other estimates. This water is assumed to be percolating down through the gypsum stack and/or through the material at the edges of the stack.

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
8/1/07 12:00 AM	**9/1/07 12:00 AM**	1,321	1,628	1,207	4,156

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
1,523	2	35	468	2,028

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	Average Extraction Water Flow gpm
8/1/07 12:00 AM	9/1/07 12:00 AM	0	0		1.8	6.2	18.5	6.9	0.6	4.8	97	88	224

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
8/1/07 12:00 AM	9/1/07 12:00 AM	3,687	19.2	5.4	28.1%	13.8	3,313	785

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
9/1/07 12:00 AM	**10/1/07 12:00 AM**	1,375	1,593	1,184	4,152

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
1,550	8	41	474	2,073

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	Average Extraction Water Flow gpm
9/1/07 12:00 AM	10/1/07 12:00 AM	22	22		2.0	3.8	18.9	4.4	0.6	4.8	71	88	238

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
9/1/07 12:00 AM	10/1/07 12:00 AM	3,888	20.3	6.0	29.8%	14.2	3,411	724

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
10/1/07 12:00 AM	**11/1/07 12:00 AM**	1,177	1,415	1,213	3,805

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
1,343	11	42	404	1,800

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	Average Extraction Water Flow gpm
10/1/07 12:00 AM	11/1/07 12:00 AM	45	26		1.9	3.2	18.0	5.7	0.5	5.0	96	81	282

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
10/1/07 12:00 AM	11/1/07 12:00 AM	4,024	21.0	4.2	20.3%	16.7	4,012	954

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
11/1/07 12:00 AM	**12/1/07 12:00 AM**	1,202	1,459	1,187	3,848

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
1,316	15	27	399	1,757

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	Average Extraction Water Flow gpm
11/1/07 12:00 AM	12/1/07 12:00 AM	45	20		2.0	3.2	17.7	7.3	0.4	5.4	100	81	282

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
11/1/07 12:00 AM	12/1/07 12:00 AM	3,713	19.4	4.8	24.6%	14.6	3,501	650

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
12/1/07 12:00 AM	**1/1/08 12:00 AM**	1,245	1,406	1,166	3,817

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
1,264	19	27	386	1,696

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	Average Extraction Water Flow gpm
12/1/07 12:00 AM	1/1/08 12:00 AM	44	20		2.1	3.2	9.9	5.3	0.0	3.7	100	80	268

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
12/1/07 12:00 AM	1/1/08 12:00 AM	3,774	19.7	4.8	24.6%	14.8	3,561	715

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start	End	Well 4	Well 5	Well 7	Average Fresh Water
Date	Date	gpm	gpm	gpm	gpm
1/1/08 12:00 AM	**2/1/08 12:00 AM**	1,205	1,418	1,293	3,916

Average PAP Area Fresh Water Consumption

Area 5	Area 6	Area 7	Area 8	Average Area Consumption
gpm	gpm	gpm	gpm	gpm
1,377	12	16	420	1,825

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start	End	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	Average Extraction Water Flow
Date	Date	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
1/1/08 12:00 AM	2/1/08 12:00 AM	43.4	20.0		2.1	3.3	9.4	5.5	0.0	3.6	72.5	63.4	45.0	0.7	10.7	5.4	285.2

Average Gypsum Thickener Operation

Start	End	Gypsum Stack Total Flow	Gypsum Stack Total Flow	Gypsum Stack Solids	Gypsum Stack Flow Solids	Gypsum Stack Water Flow	Gypsum Stack Water Flow	Decant Return Water Flow
Date	Date	gpm	ton/min	ton/min	wt.%	ton/min	gpm	gpm
1/1/08 12:00 AM	2/1/08 12:00 AM	3,593	18.7	4.8	25.5%	14.0	3,348	493

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
2/1/08 12:00 AM	**3/1/08 12:00 AM**	1,078	1,255	1,442	3,775

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
1,258	14	37	307	1,616

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
2/1/08 12:00 AM	3/1/08 12:00 AM	44.9	19.7		1.9	3.1	17.3	8.0	0.0	4.6	114.8	70.6	196.7	92.8	38.5	54.1	667.0

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
2/1/08 12:00 AM	3/1/08 12:00 AM	3,657	19.1	4.7	24.5%	14.4	3,455	597

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start	End	Well 4	Well 5	Well 7	Average Fresh Water
Date	Date	gpm	gpm	gpm	gpm
3/1/08 12:00 AM	**4/1/08 12:00 AM**	1,007	1,261	1,442	3,710

Average PAP Area Fresh Water Consumption

Area 5	Area 6	Area 7	Area 8	Average Area Consumption
gpm	gpm	gpm	gpm	gpm
1,211	27	35	311	1,584

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start	End	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	Average Extraction Water Flow
Date	Date	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
3/1/08 12:00 AM	4/1/08 12:00 AM	43.7	20.0		1.5	3.0	17.3	3.8	0.0	4.6	111.6	53.9	214.9	132.2	29.6	51.7	687.9

Average Gypsum Thickener Operation

Start	End	Gypsum Stack Total Flow	Gypsum Stack Total Flow	Gypsum Stack Solids	Gypsum Stack Flow Solids	Gypsum Stack Water Flow	Gypsum Stack Water Flow	Decant Return Water Flow
Date	Date	gpm	ton/min	ton/min	wt.%	ton/min	gpm	gpm
3/1/08 12:00 AM	4/1/08 12:00 AM	3,756	19.6	4.7	24.1%	14.9	3,569	687

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
4/1/08 12:00 AM	**5/1/08 12:00 AM**	1,088	1,354	1,407	3,849

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
1,367	22	36	344	1,769

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
4/1/08 12:00 AM	5/1/08 12:00 AM	20.7	14.4		0.8	2.0	7.2	2.6	0.0	2.3	56.6	32.3	261.8	75.5	12.3	28.0	516.6

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
4/1/08 12:00 AM	5/1/08 12:00 AM	4,047	21.1	4.8	23.0%	16.3	3,897	1,048

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
5/1/08 12:00 AM	**6/1/08 12:00 AM**	566	1,525	1,410	3,501

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
1,132	5	35	266	1,438

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
5/1/08 12:00 AM	6/1/08 12:00 AM	9.8	25.8		0.4	1.7	2.9	4.3	0.0	2.4	65.3	52.8	309.5	57.3	22.7	33.6	588.5

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
5/1/08 12:00 AM	6/1/08 12:00 AM	3,414	17.8	3.4	17.0%	14.4	3,463	615

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
6/1/08 12:00 AM	**7/1/08 12:00 AM**	585	1,025	1,302	2,912

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
1,147	4	36	268	1,455

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
6/1/08 12:00 AM	7/1/08 12:00 AM	11.9	2.8		1.5	2.4	1.5	4.7	0.7	2.2	83.8	48.9	321.5	68.9	14.9	24.8	590.5

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
6/1/08 12:00 AM	7/1/08 12:00 AM	2,858	14.9	3.4	20.0%	11.5	2,759	619

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
7/1/08 12:00 AM	**8/1/08 12:00 AM**	837	1,320	1,265	3,422

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
881	8	35	497	1,421

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
7/1/08 12:00 AM	8/1/08 12:00 AM	25.6	29.5		1.4	1.7	9.6	3.8	0.4	3.4	94.3	57.4	376.5	120.8	23.3	54.1	801.7

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
7/1/08 12:00 AM	8/1/08 12:00 AM	3,525	18.4	4.2	22.4%	14.2	3,409	757

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
8/1/08 12:00 AM	**9/1/08 12:00 AM**	601	1,528	1,409	3,538

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
993	11	35	458	1,497

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
8/1/08 12:00 AM	9/1/08 12:00 AM	0.2	0.2		1.6	1.7	10.1	3.9	0.4	3.5	94.5	57.0	392.4	125.0	24.0	54.0	768.4

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
8/1/08 12:00 AM	9/1/08 12:00 AM	3,781	19.7	4.7	23.8%	15.0	3,605	856

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start	End	Well 4	Well 5	Well 7	Average Fresh Water
Date	Date	gpm	gpm	gpm	gpm
9/1/08 12:00 AM	**10/1/08 12:00 AM**	873	1,256	1,390	3,519

Average PAP Area Fresh Water Consumption

Area 5	Area 6	Area 7	Area 8	Average Area Consumption
gpm	gpm	gpm	gpm	gpm
979	16	36	459	1,490

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start	End	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	Average Extraction Water Flow
Date	Date	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
9/1/08 12:00 AM	10/1/08 12:00 AM	0.1	0.0		1.6	1.5	10.0	3.9	0.4	3.8	93.5	55.2	390.5	125.0	24.0	54.0	763.6

Average Gypsum Thickener Operation

Start	End	Gypsum Stack Total Flow	Gypsum Stack Total Flow	Gypsum Stack Solids	Gypsum Stack Flow Solids	Gypsum Stack Water Flow	Gypsum Stack Water Flow	Decant Return Water Flow
Date	Date	gpm	ton/min	ton/min	wt.%	ton/min	gpm	gpm
9/1/08 12:00 AM	10/1/08 12:00 AM	3,526	18.4	4.6	24.9%	13.8	3,313	529

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
10/1/08 12:00 AM	**11/1/08 12:00 AM**	841	1,070	1,393	3,304

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
941	16	26	455	1,438

Area Definition:

Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)

Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)

Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building

Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
10/1/08 12:00 AM	11/1/08 12:00 AM	18.3	21.5		1.9	1.4	10.0	3.9	0.4	3.8	90.7	61.7	386.6	127.2	24.0	56.6	808.0

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
10/1/08 12:00 AM	11/1/08 12:00 AM	3,520	18.3	4.5	24.8%	13.8	3,311	532

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
11/1/08 12:00 AM	12/1/08 12:00 AM	706	903	1,412	3,021

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
817	17	54	347	1,235

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
11/1/08 12:00 AM	12/1/08 12:00 AM	17.2	19.8		2.1	1.3	10.0	3.9	0.4	3.8	88.2	75.9	387.0	98.8	24.0	75.0	807.3

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
11/1/08 12:00 AM	12/1/08 12:00 AM	3,314	17.3	3.7	21.5%	13.6	3,251	442

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
12/1/08 12:00 AM	**1/1/09 12:00 AM**	752	875	1,214	2,841

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
851	22	39	344	1,256

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
12/1/08 12:00 AM	1/1/09 12:00 AM	16.7	16.4		1.9	1.2	10.0	3.9	0.3	3.7	86.9	76.1	389.3	99.0	24.0	75.0	804.3

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
12/1/08 12:00 AM	1/1/09 12:00 AM	2,879	15.0	2.7	18.2%	12.3	2,941	349

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
12/1/08 12:00 AM	**1/1/09 12:00 AM**	1,229	221	1,348	2,798

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
829	27	58	321	1,235

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
12/1/08 12:00 AM	1/1/09 12:00 AM	11.7	34.1		1.8	1.1	9.9	3.9	0.0	3.5	87.9	71.9	400.4	99.0	21.5	73.4	820.0

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
12/1/08 12:00 AM	1/1/09 12:00 AM	2,975	15.5	2.7	16.8%	12.8	3,069	456

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
2/1/09 12:00 AM	**3/1/09 12:00 AM**	1,109	997	728	2,834

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
695	25	73	334	1,127

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
2/1/09 12:00 AM	3/1/09 12:00 AM	19.1	49.3		1.6	1.0	10.0	3.9	0.0	3.5	84.7	67.5	397.1	99.0	24.0	57.6	818.4

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
2/1/09 12:00 AM	3/1/09 12:00 AM	4,023	21.0	4.7	22.5%	16.3	3,899	780

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
3/1/09 12:00 AM	**4/1/09 12:00 AM**	923	936	1,054	2,913

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
782	9	52	311	1,154

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start	End	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	Average Extraction Water Flow
Date	Date	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
3/1/09 12:00 AM	4/1/09 12:00 AM	15.9	49.3		1.8	0.9	10.0	3.9	0.3	3.4	83.4	65.9	406.3	99.1	24.0	57.6	821.9

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
3/1/09 12:00 AM	4/1/09 12:00 AM	4,317	22.5	4.7	20.7%	17.8	4,276	1,147

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
4/1/09 12:00 AM	**5/1/09 12:00 AM**	981	879	1,045	2,905

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
731	3	42	303	1,079

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
4/1/09 12:00 AM	5/1/09 12:00 AM	15.9	49.4		2.1	0.7	10.0	3.9	0.0	3.4	85.6	68.9	409.1	116.1	24.0	69.6	858.8

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
4/1/09 12:00 AM	5/1/09 12:00 AM	4,614	24.0	4.7	19.6%	19.4	4,642	1,550

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
5/1/09 12:00 AM	**6/1/09 12:00 AM**	463	895	621	1,979

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
441	2	34	116	593

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
5/1/09 12:00 AM	6/1/09 12:00 AM	15.3	47.2		2.2	0.3	9.6	3.8	0.0	3.3	78.8	62.4	387.1	111.0	7.8	68.4	797.1

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
5/1/09 12:00 AM	6/1/09 12:00 AM	3,448	18.0	2.8	15.2%	15.2	3,642	1,385

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
6/1/09 12:00 AM	**7/1/09 12:00 AM**	173	303	339	815

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
248	9	21	112	390

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
6/1/09 12:00 AM	7/1/09 12:00 AM	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	4.7	0.0	0.0	1.0	6.9

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
6/1/09 12:00 AM	7/1/09 12:00 AM	651	3.4	0.2	7.0%	3.2	771	114

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start	End	Well 4	Well 5	Well 7	Average Fresh Water
Date	Date	gpm	gpm	gpm	gpm
7/1/09 12:00 AM	**8/1/09 12:00 AM**	925	1,217	1,233	3,375

Average PAP Area Fresh Water Consumption

Area 5	Area 6	Area 7	Area 8	Average Area Consumption
gpm	gpm	gpm	gpm	gpm
874	2	933	385	2,194

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start	End	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	Average Extraction Water Flow
Date	Date	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
7/1/09 12:00 AM	8/1/09 12:00 AM	30.9	38.1		2.8	0.1	9.0	7.2	0.1	3.4	84.1	26.0	357.4	112.3	15.9	65.3	752.7

Average Gypsum Thickener Operation

Start	End	Gypsum Stack Total Flow	Gypsum Stack Total Flow	Gypsum Stack Solids	Gypsum Stack Flow Solids	Gypsum Stack Water Flow	Gypsum Stack Water Flow	Decant Return Water Flow
Date	Date	gpm	ton/min	ton/min	wt.%	ton/min	gpm	gpm
7/1/09 12:00 AM	8/1/09 12:00 AM	4,510	23.5	4.8	20.7%	18.7	4,480	1,399

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
8/1/09 12:00 AM	**9/1/09 12:00 AM**	1,074	909	918	2,901

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
470	2	931	277	1,680

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start	End	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	Average Extraction Water Flow
Date	Date	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
8/1/09 12:00 AM	9/1/09 12:00 AM	28.5	41.6		1.9	0.0	7.0	5.8	0.0	3.5	80.3	63.8	408.1	116.1	18.6	57.1	832.3

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
8/1/09 12:00 AM	9/1/09 12:00 AM	3,918	20.4	4.8	23.7%	15.6	3,741	1,103

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start	End	Well 4	Well 5	Well 7	Average Fresh Water
Date	Date	gpm	gpm	gpm	gpm
9/1/09 12:00 AM	**10/1/09 12:00 AM**	1,020	882	909	2,811

Average PAP Area Fresh Water Consumption

Area 5	Area 6	Area 7	Area 8	Average Area Consumption
gpm	gpm	gpm	gpm	gpm
417	3	886	263	1,569

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start	End	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	Average Extraction Water Flow
Date	Date	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
9/1/09 12:00 AM	10/1/09 12:00 AM	30.0	43.9		2.0	0.0	15.4	7.7	0.0	3.9	76.6	61.9	404.2	116.1	18.6	55.9	836.2

Average Gypsum Thickener Operation

Start	End	Gypsum Stack Total Flow	Gypsum Stack Total Flow	Gypsum Stack Solids	Gypsum Stack Flow Solids	Gypsum Stack Water Flow	Gypsum Stack Water Flow	Decant Return Water Flow
Date	Date	gpm	ton/min	ton/min	wt.%	ton/min	gpm	gpm
9/1/09 12:00 AM	10/1/09 12:00 AM	3,586	18.7	4.6	24.9%	14.1	3,385	844

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
10/1/09 12:00 AM	**11/1/09 12:00 AM**	1,027	869	899	2,795

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
449	5	893	308	1,655

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start	End	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	Average Extraction Water Flow
Date	Date	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm	gpm
10/1/09 12:00 AM	11/1/09 12:00 AM	29.5	45.5		2.4	0.0	16.6	4.3	0.0	4.4	77.2	60.0	396.8	116.1	18.6	55.4	826.9

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
10/1/09 12:00 AM	11/1/09 12:00 AM	3,738	19.5	4.6	23.7%	14.9	3,565	672

JR Simplot Company, Don Plant Environmental Monthly Report -- EPA Superfund Extraction Water

Simplot

The following is generated to define data for the EPA as required for superfund reporting. This data is requred by the 4th of each month to be submitted to Corporate ES&H for report generation and submission to the EPA by the 10th of each month.

AgriBusiness

Shell Generated 11/1/2004

Average Don Plant Fresh Well Water Production

Start Date	End Date	Well 4 gpm	Well 5 gpm	Well 7 gpm	Average Fresh Water gpm
11/1/09 12:00 AM	12/1/09 12:00 AM	956	952	1,015	2,923

Average PAP Area Fresh Water Consumption

Area 5 gpm	Area 6 gpm	Area 7 gpm	Area 8 gpm	Average Area Consumption gpm
452	7	901	312	1,672

Area Definition:
Area 5: Phosphoric Acid Plant (PAP) North Facilities; PAP Belt Filter Scrubber; PAP Evaporators; Purified Phosphoric Acid Plant (PPA)
Area 6: PAP Water Reclaim (Gypsum Thickeners, etc)
Area 7: PAP Ore Receiving, Ore Thickener, Stores Buildings, Safety Building
Area 8: Granulation III, PAP Cooling Tower Cold Pit Make-up

Average Extraction Well Water Production

Start Date	End Date	401 gpm	402 gpm	403 gpm	404 gpm	405 gpm	406 gpm	407 gpm	408 gpm	409 gpm	410 gpm	411 gpm	412 gpm	413 gpm	414 gpm	415 gpm	Average Extraction Water Flow gpm
11/1/09 12:00 AM	12/1/09 12:00 AM	29.4	46.0		2.3	0.0	16.8	4.2	0.0	3.5	69.4	58.8	407.0	116.3	17.8	54.0	825.4

Average Gypsum Thickener Operation

Start Date	End Date	Gypsum Stack Total Flow gpm	Gypsum Stack Total Flow ton/min	Gypsum Stack Solids ton/min	Gypsum Stack Flow Solids wt.%	Gypsum Stack Water Flow ton/min	Gypsum Stack Water Flow gpm	Decant Return Water Flow gpm
11/1/09 12:00 AM	12/1/09 12:00 AM	3,804	19.8	4.8	24.2%	15.1	3,612	830

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APPENDIX B

Groundwater Flow and Mass Flux Calculations

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Overview

OBJECTIVE:
Revise the mass balance model to reflect 2008 site conditions, and use it to predict extraction system performance.

METHOD:
Perform a mass balance for constituents in groundwater from the source area to the point of discharge to the Portneuf River using 2008 site data. Use the model to predict extraction system performance and calculate load and concentration at the discharge to the Portneuf River.

Step 1 Calculate Model Parameters
- Estimate groundwater flow discharging to the river from the Site (Table 1)
- Estimate concentration of unaffected groundwater discharging to the Portneuf river (Table 2)
- Estimate flow rate of stack-affected and PAP-affected groundwater (Table 3)
- Estimate mass flux rate of constituents in affected groundwater (Table 4).
- Estimate mass removal rate by operation of SWP-4 (at time TMDL river data were collected) (Table 5)
- Estimate mass of constituents removed along groundwater flow path by attenuation mechanisms (Table 6)

Step 2 Set up Model for No Extraction System Conditions

Step 3 Use the Model to Predict the Groundwater Extraction Necessary to Achieve the Arsenic MCL at the Springs

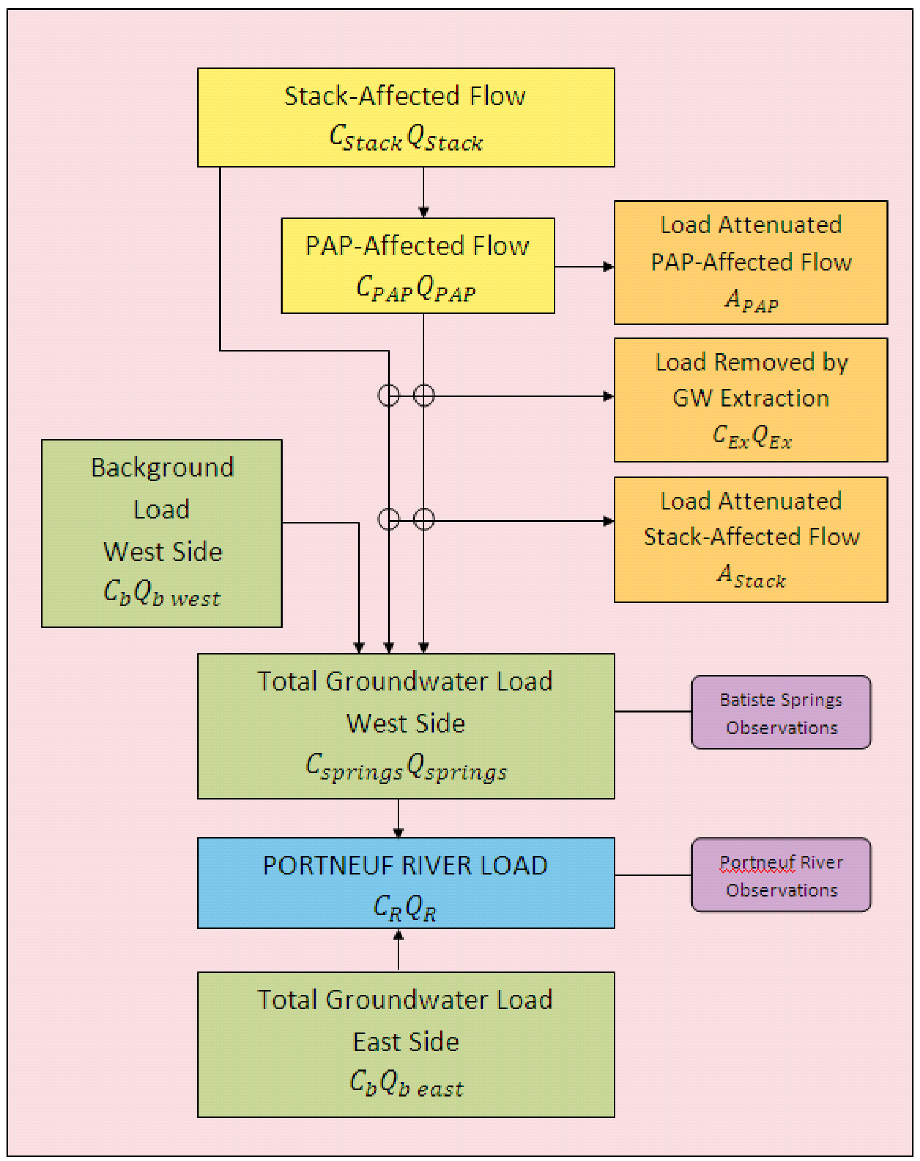


Table 1: Estimate Groundwater Flow and Average Constituent Concentration Discharging to the Portneuf River from the West (Site) Side

METHOD:

Groundwater discharge flows to the river from the site are calculated based on the IDEQ TMDL river and springs data assuming that the change in flow and concentrations observed in the Portneuf river is solely due to the discharge of groundwater to the river.

$$Qsprings = (\Delta(QrCr) - Cb\Delta Qr)/(Csprings-Cb)$$

$$\Delta(QrCr) = QT3*CT3 - QT1*CT1$$

where:

Qsprings =	Flow rate of groundwater discharge to the river from the west side of the river
Csprings =	Constituent concentration in the groundwater discharge (springs) to the river from the west side of the river
Cb =	Constituent concentration in unaffected groundwater
Qr =	Flow rate measured in river.
Cr =	Constituent concentration measured in river
QT3 =	River flow measured at transect T3
QT1 =	River flow measured at transect T1
CT3 =	Constituent concentration measured in river at transect T3
CT1 =	Constituent concentration measured in river at transect T1

Flow and concentration data were collected in three consecutive years. The calculation is performed below for each event, where data are available.

RESULTS:

SULFATE - (concentration data only available for 2002)

September, 2002		
Station T-1, above interstate.		
Sulfate concentration	56.9	mg/L
Flow rate	54.2	cfs
Station T-3, above Pocatello STP.		
Sulfate concentration	87.8	mg/L
Flow rate	122.03	cfs
Background Groundwater Concentration	57	mg/L
Spring Concentration (west side)	228	
Estimated Total Groundwater flux		
Sulfate average concentration	112.49	mg/L
Flow rate	67.83	cfs
Load	18,668	kg/day
West Side Groundwater Discharge	22.0	cfs
Percent of Total Groundwater Discharge	32%	

ORTHOPHOSPHATE AS PHOSPHORUS

September 13-14, 2000		
Station T-1, above interstate.		
Phosphorus concentration	0.008	mg/L
Flow rate	77.91	cfs
Station T-3, above Pocatello STP.		
Phosphorus concentration	1.93	mg/L
Flow rate	139.59	cfs
Background Groundwater Concentration	0.008	mg/L
Spring Concentration (west side)	6.6	
Estimated Total Groundwater flux		
Phosphorus average concentration	4.36	mg/L
Flow rate	61.68	cfs
Load	657.6	kg/day
West Side Groundwater Discharge	40.69963	cfs
Percent of Total Groundwater Discharge	66%	

August 20-22, 2001		
Station T-1, above interstate.		
Phosphorus concentration	0.01	mg/L
Flow rate	45.22	cfs
Station T-3, above Pocatello STP.		
Phosphorus concentration	2.22	mg/L
Flow rate	103.18	cfs
Background Groundwater Concentration	0.008	mg/L
Spring Concentration (west side)	6.6	
Estimated Total Groundwater flux		
Phosphorus average concentration	3.94	mg/L
Flow rate	57.96	cfs
Load	559.3	kg/day
West Side Groundwater Discharge	34.60918	cfs
Percent of Total Groundwater Discharge	60%	

September 2002		
Station T-1, above interstate.		
Phosphorus concentration	0.017	mg/L
Flow rate	54.2	cfs
Station T-3, above Pocatello STP.		
Phosphorus concentration	1.82	mg/L
Flow rate	122.03	cfs
Background Groundwater Concentration	0.008	mg/L
Spring Concentration (west side)	6.6	
Estimated Total Groundwater flux		
Phosphorus average concentration	3.26	mg/L
Flow rate	67.83	cfs
Load	541.1	kg/day
West Side Groundwater Discharge	33.46944	cfs
Percent of Total Groundwater Discharge	49%	

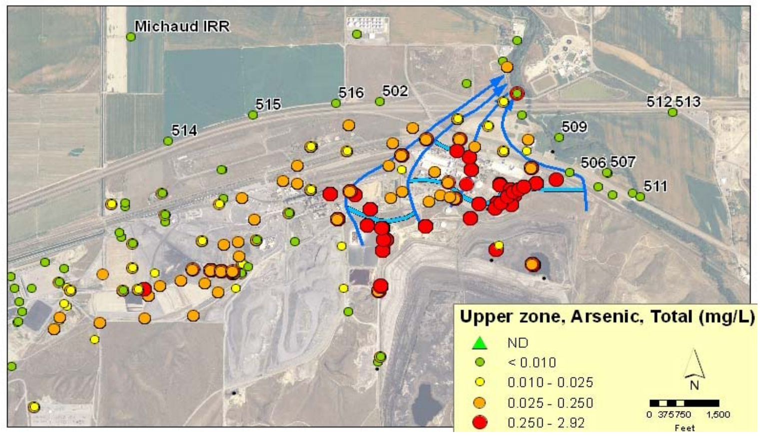
Table 2: Estimate Concentration of Unaffected Groundwater Discharging to the Portneuf River

METHOD:

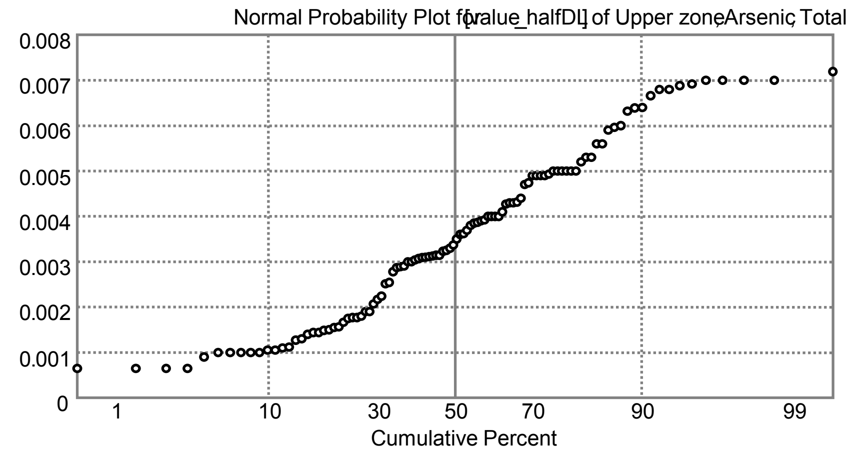
1: Identify wells that are located outside of the zone of influence of stack-affected groundwater (spatial distribution of constituents of concern (COCs))

2: Calculate the 95% UCL of the mean of COCs for unaffected wells

Upper zone arsenic concentrations (total, mg/L).

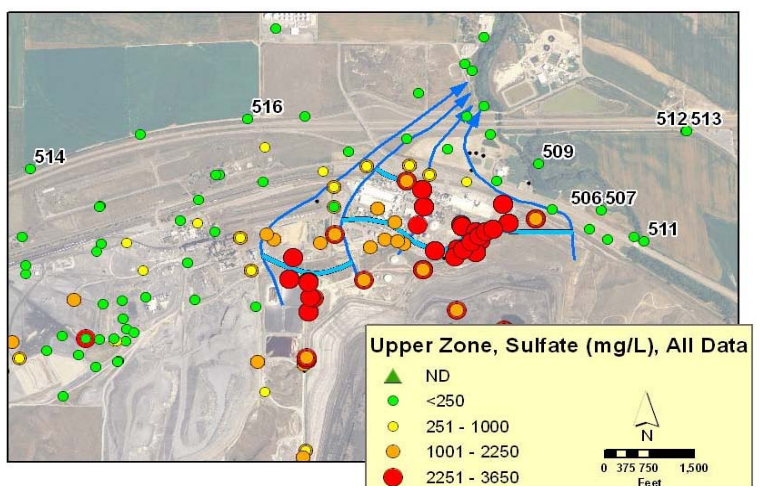


Normal probability plot of all arsenic concentration data from wells 502, 506, 507, 509, 511, 512, 513, 514, 515, 516 and Michaud IRR (total, mg/L).

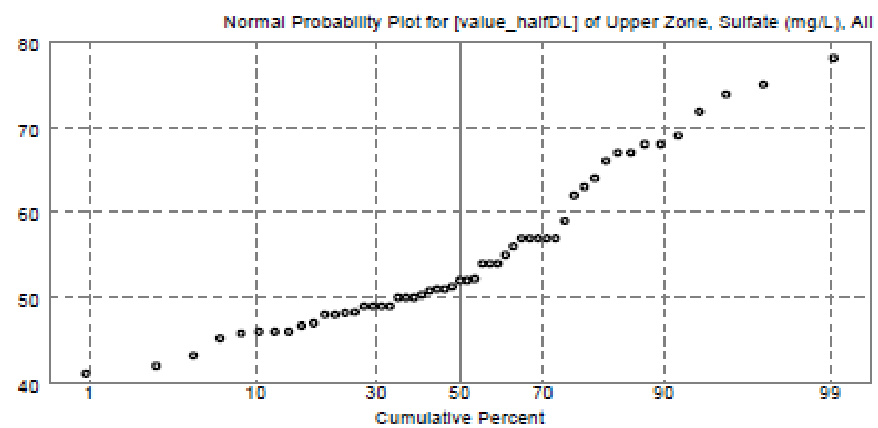


Count	106
Minimum	6.5E-04
Maximum	7.19E-03
Sum	0.377915
Mean	3.565236E-03
Median	3.435E-03
StdDev	1.885757E-03
Variance	3.556079E-06
Skewness	0.2204355
Kurtosis	-0.9680541
95 UCL	3.869283E-03

Upper zone sulfate concentrations (total, mg/L).

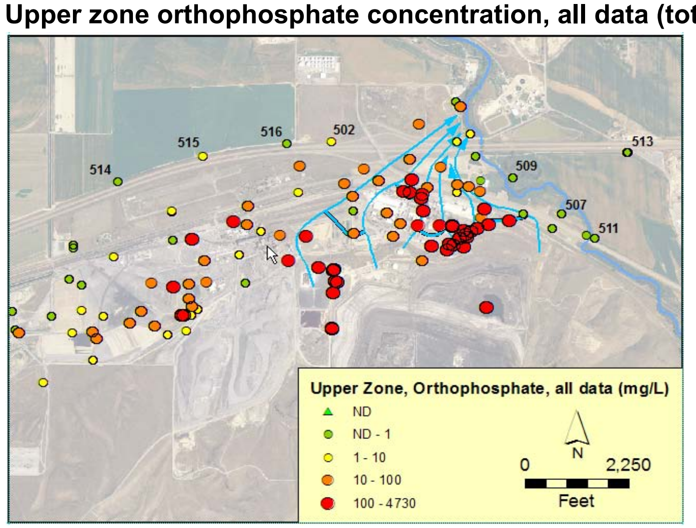


Normal probability plot of all sulfate concentration data from wells 506, 507, 509, 511, 512, 513, 514, and 516 (total, mg/L).

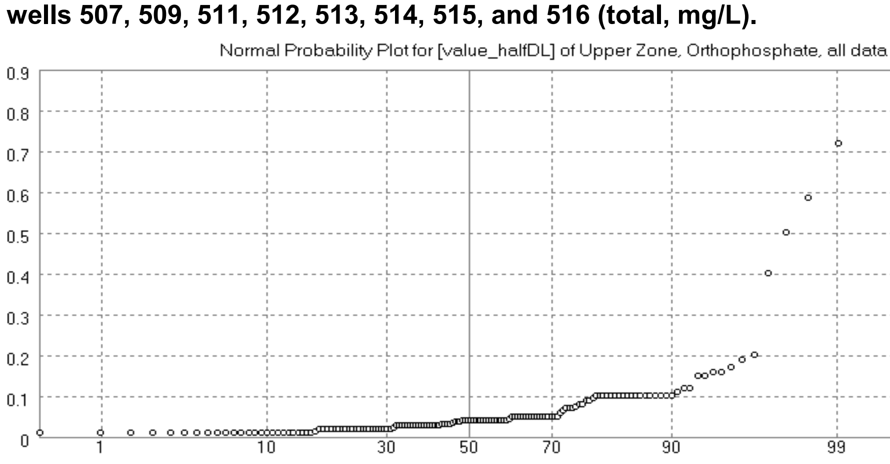


Count	53
Minimum	41.1
Maximum	78.1
Sum	2907.8
Mean	54.86415
Median	52.0
StdDev	9.117525
Variance	83.12927
Skewness	0.8594934
Kurtosis	-0.1217799
95 UCL	56.95564

Upper zone orthophosphate concentration, all data (total, mg/L)



Normal probability plot of all orthophosphate concentration data from wells 507, 509, 511, 512, 513, 514, 515, and 516 (total, mg/L).



Count	154
Minimum	1.0E-02
Maximum	0.82
Sum	10.3275
Mean	6.706169E-02
Median	4.0E-02
StdDev	0.1099283
Variance	1.208423E-02
Skewness	4.798261
Kurtosis	25.98207
95 UCL	8.163355E-02

Table 3: Estimated groundwater flow rate of all stack-affected groundwater.

METHOD:
The rate of flow of stack affected groundwater from the site is calculated as follows:

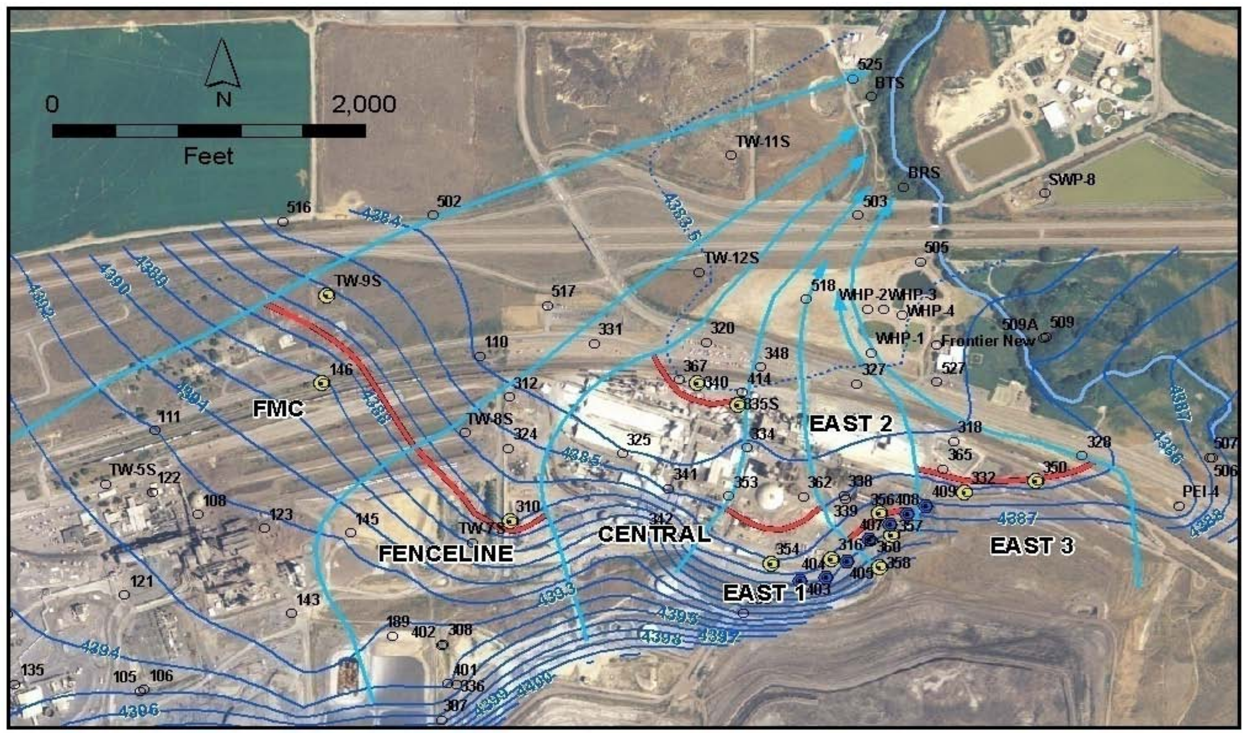
$$Qx = Kx * ix * Ax$$

where:
- Qx = Groundwater flow rate for region x
- Kx = Average hydraulic conductivity for region x
- ix = Average hydraulic gradient in region x
- Ax = Cross sectional flow area for region x

The calculation involves the following steps:

1. The full extent of stack affected groundwater flow is divided into contiguous regions (see figures below).
2. The cross sectional area for each region is calculated using the hydrogeologic model developed in ARCGis.
3. The specific hydraulic properties (K and i) of each region are estimated from available information.

Upper Zone Flow:



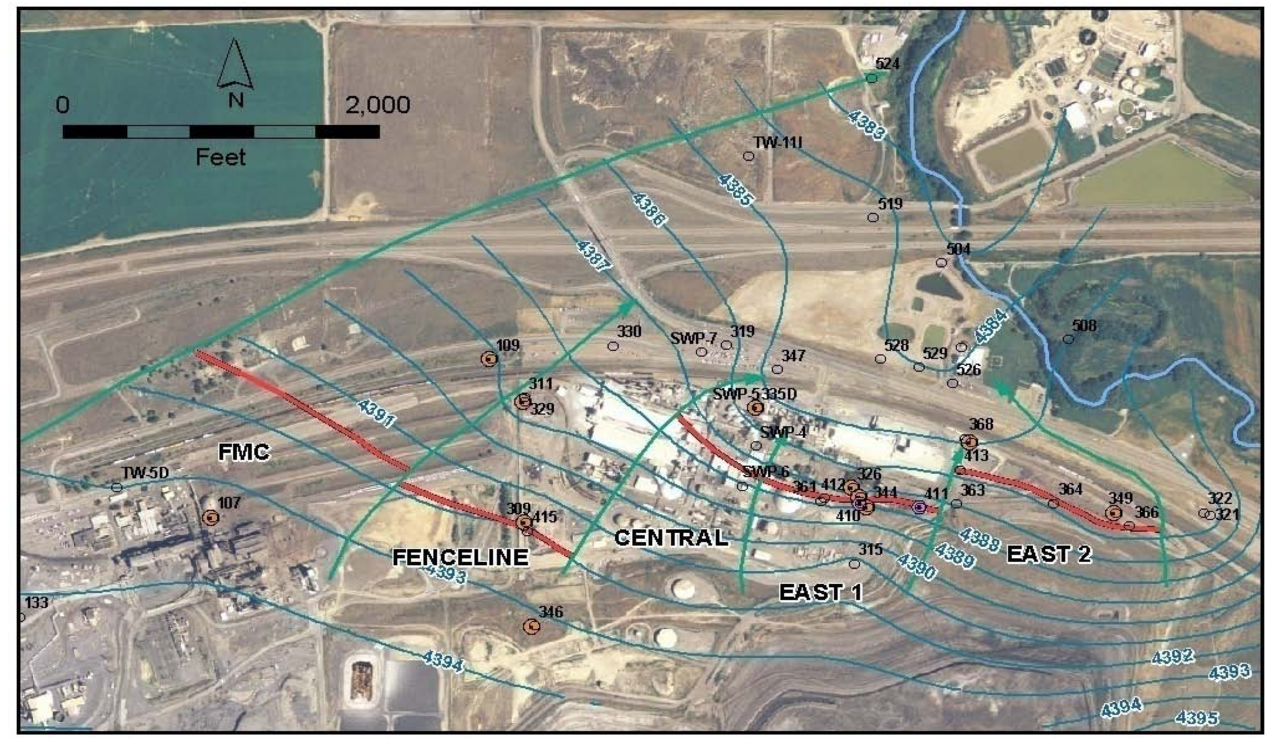
2008 Conditions

	Width (ft)	Average Thickness (ft)	Area (sf)	L min	L max	L avg	delta h	Average Gradient (ft/ft)	Kmin (ft/day)	Kmax (ft/day)	Kav (ft/day)	Q (cfd)	Q (gpm)
East Plant Area 1													
Entire zone	714	17.9	12,772	343	452	398	1.5	0.0038	27	196	200	9,639	50
East Plant Area 2*													
Entire zone	494	11.8	5,834	228	242	235	2.0	0.0085	22	700	200	9,930	52
East Plant Area 3*													
Entire zone	1184	15.6	18,482	202	581	392	1.0	0.0026			200	9,442	49
Central Plant Area													
Stack-affected	722.11	15.0	10,837	686	988	837	0.8	0.0010			2600	26,930	140
340 plume	10	15.0	150	686	988	837	0.8	0.0010			2600	373	2
419 plume	60	15.0	900	686	988	837	0.8	0.0010			2600	2,237	12
													126
Fenceline Area													
Entire zone	1116	24.3	27,086	98	172	135	1	0.0074	34	161	100	20,064	104
FMC Area*													
Entire zone	1829	39.8	72,712	447	561	504	1	0.0020	197	501	250	36,067	187

Simplot Subtotal UZ Flow 395
FMC Subtotal UZ Flow 187

Total Simplot Flow	1,423	gpm	3.18	0.00556	660
Total FMC Flow	187	gpm	0.42		
Total Affected Flow	1,610	gpm	3.60		

Lower Zone Flow:



	Width (ft)	Average Thickness (ft)	Area (sf)	L min	L max	L avg	delta h	Average Gradient (ft/ft)	Kmin (ft/day)	Kmax (ft/day)	Kav (ft/day)	Q (cfd)	Q (gpm)
East Plant Area 1													
High K	1160	77.2	89563	94	174	134	1	0.0075	29	162	162	108,278	562
Low K	1160	35.5	41213	94	174	134	1	0.0075	29	162	50	15,378	80
												123,656	642
East Plant Area 2													
High K zone	1406	33.4	46,959	303	580	442	1.5	0.0034	60	524	150	23,932	124
Low K zone	1406	12.3	17,241	303	580	442	1.5	0.0034	60	524	75	4,393	23
													147
Central Plant Area													
High K zone	695	56.3	39,098	174	297	236	1	0.0042			200	33,204	172
Low K zone	695	21.7	15,112	174	297	236	1	0.0042			50	3,208	17
													189
Fenceline Area													
Entire zone	486	65.2	31,672	218	283	251	1	0.0040			75	9,483	49

Simplot Subtotal LZ Flow 1,028

Table 3 (cont.): Estimated groundwater flow rate of all stack-affected groundwater.

2000 Conditions

	Width (ft)	Average Thickness (ft)	Area (sf)	L min	L max	L avg	delta h	Average Gradient (ft/ft)	Kmin (ft/day)	Kmax (ft/day)	Kav (ft/day)	Q (cfd)	Q (gpm)
East Plant Area 1													
Entire zone	714	17.9	12,772	343	452	398	1.5	0.0038	27	196	200	9,639	50
East Plant Area 2*													
Entire zone	494	11.8	5,834	228	242	235	2.0	0.0085	22	700	200	9,930	52
East Plant Area 3*													
Entire zone	1184	15.6	18,482	202	581	392	1.0	0.0026			200	9,442	49
Central Plant Area													
Stack-affected	722.11	15.0	10,837	686	988	837	0.8	0.0010			2600	26,930	140
340 plume	20	15.0	300	686	988	837	0.8	0.0010			2600	746	4
335s plume	50	15.0	750	686	988	837	0.8	0.0010			2600	1,864	10
													126
Fenceline Area													
Entire zone	1116	24.3	27,086	98	172	135	1	0.0074	34	161	100	20,064	104
FMC Area*													
Entire zone	1829	39.8	72,712	447	561	504	1	0.0020	197	501	250	36,067	187

Simplot Subtotal UZ Flow 395
FMC Subtotal UZ Flow 187

Total Simplot Flow	1,431	gpm	3.20	0.00556	660
Total FMC Flow	187	gpm	0.42		
Total Affected Flow	1,618	gpm	3.61		

	Width (ft)	Average Thickness (ft)	Area (sf)	L min	L max	L avg	delta h	Average Gradient (ft/ft)	Kmin (ft/day)	Kmax (ft/day)	Kav (ft/day)	Q (cfd)	Q (gpm)
East Plant Area 1													
High K	1160	77.2	89563	94	174	134	1	0.0075	29	162	162	108,278	562
Low K	1160	35.5	41213	94	174	134	1	0.0075	29	162	50	15,378	80
												123,656	642
East Plant Area 2													
High K zone	1406	33.4	46,959	303	580	442	1.5	0.0034	60	524	150	23,932	124
Low K zone	1406	12.3	17,241	303	580	442	1.5	0.0034	60	524	75	4,393	23
													147
Central Plant Area													
High K zone	695	56.3	39,098	174	297	236	1	0.0042			200	33,204	172
Low K zone	695	21.7	15,112	174	297	236	1	0.0042			75	4,813	25
													197
Fenceline Area													
Entire zone	486	65.2	31,672	218	283	251	1	0.0040			75	9,483	49

Simplot Subtotal LZ Flow 1,036

Table 4: Estimated mass flux rate of constituents in stack-affected groundwater.

METHOD:
Mass flux rates are calculated as follows:

Mnx = Qx * Cn

where:
Mnx = Mass flux rate for constituent n in region x
Qx = Groundwater flow rate for region x
Cnx = Average concentration of constituent n in region x

Average constituent concentrations are estimated by using available concentration data from wells completed within 250 feet of the line of assessment.

RESULTS: **2008-9**

ORTHOPHOPHATE

	Q (gpm)	Mean P (mg/L)	P Load (kg/day)	Fraction of Total Load	
Upper Zone East Plant Area 1					
	50	276	75	4.1%	165
Upper Zone East Plant Area 2					
	52	430	121	6.6%	266
Upper Zone East Plant Area 3					
	49	300	80	4.4%	176
Upper Zone Central Plant Area					
Stack	126	96	66	3.6%	145
340	2	2,991	32	1.7%	69
419	12	7,338	464	25.3%	1,021
			562	30.6%	1,235
Upper Zone West Plant Area					
	104	62	35	1.9%	77
Upper Zone FMC					
	187	3	3	0.2%	7
Lower Zone East Plant Area 1					
	642	210	734	40.0%	1,615
Lower Zone East Plant Area 2					
	147	166	133	7.2%	292
Lower Zone Central Plant Area					
	189	85	88	4.8%	193
Lower Zone Fenceline Plant Area					
	49	20	5	0.3%	12
TOTAL	1,610	209.2	1,836	100.0%	4,039
			4,039.0	lb/day	

1,447 528

SULFATE

	Q (gpm)	Mean SO4 (mg/L)	SO4 Load (kg/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	2,707	738	4.3%
Upper Zone East Plant Area 2				
	52	2,990	840	4.9%
Upper Zone East Plant Area 3				
	49	1,985	530	3.1%
Upper Zone Central Plant Area				
Stack	126	1,465	1,008	5.9%
340	2	1,964	21	0.1%
419	12	1,530	97	0.6%
			1,125	6.6%
Upper Zone West Plant Area				
	104	1,595	905	5.3%
Upper Zone FMC				
	187	286	292	1.7%
Lower Zone East Plant Area 1				
	642	2,334	8,160	47.8%
Lower Zone East Plant Area 2				
	147	1,966	1,575	9.2%
Lower Zone Central Plant Area				
	189	2,500	2,574	15.1%
Lower Zone Fenceline Plant Area				
	49	1,200	322	1.9%
TOTAL	1,610	1,944.0	17,059	100.0%
			37,531	lb/day

ARSENIC

	Q (gpm)	Mean As (mg/L)	As Load (kg/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	0.474	0.129	5.4%
Upper Zone East Plant Area 2				
	52	0.309	0.087	3.6%
Upper Zone East Plant Area 3				
	49	0.250	0.067	2.8%
Upper Zone Central Plant Area				
Stack	126	0.219	0.150	6.3%
340	2	0.882	0.009	0.4%
419	12	0.311	0.020	0.8%
			0.179	7.5%
Upper Zone West Plant Area				
	104	0.250	0.142	5.9%
Upper Zone FMC				
	187	0.084	0.086	3.6%
Lower Zone East Plant Area 1				
	642	0.325	1.136	47.5%
Lower Zone East Plant Area 2				
	147	0.209	0.167	7.0%
Lower Zone Central Plant Area				
	189	0.350	0.360	15.1%
Lower Zone Fenceline Plant Area				
	49	0.150	0.040	1.7%
TOTAL	1,610	0.273	2.394	100.0%
			5.27	lb/day

Table 4 (cont.): Estimated mass flux rate of constituents in stack-affected groundwater.

RESULTS: **2000**

ORTHOPHOPHATE

	Q (gpm)	Mean P (mg/L)	P Load (lb/day)	Fraction of Total Load	
Upper Zone East Plant Area 1					
	50	100	27	2.3%	60
Upper Zone East Plant Area 2					
	52	200	56	4.8%	124
Upper Zone East Plant Area 3					
	49	50	13	1.1%	29
Upper Zone Central Plant Area					
Stack	126	100	69	5.8%	151
340	4	2,000	42	3.6%	93
335s	10	4,000	211	17.9%	464
			322	27.4%	708
Upper Zone West Plant Area					
	104	17	10	0.8%	21
Upper Zone FMC					
	187	5	5	0.4%	11
Lower Zone East Plant Area 1					
	642	150	524	44.6%	1,154
Lower Zone East Plant Area 2					
	147	150	120	10.2%	264
Lower Zone Central Plant Area					
	197	85	91	7.8%	201
Lower Zone West Plant Area					
	49	25	7	0.6%	15
TOTAL	1,618	133.3	1,176	100.0%	
			2,592.3	lb/day	

SULFATE

	Q (gpm)	Mean SO_4 (mg/L)	SO4 Load (kg/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	2,700	736	4.8%
Upper Zone East Plant Area 2				
	52	2,700	758	4.9%
Upper Zone East Plant Area 3				
	49	1,900	507	3.3%
Upper Zone Central Plant Area				
Stack	126	1,800	1,238	8.1%
340	4	1,800	38	0.2%
335s	10	2,500	132	0.9%
			1,407	9.2%
Upper Zone West Plant Area				
	104	750	425	2.8%
Upper Zone FMC				
	187	750	765	5.0%
Lower Zone East Plant Area 1				
	562	2,000	6,123	39.9%
Lower Zone East Plant Area 2				
	147	2,000	1,602	10.4%
Lower Zone Central Plant Area				
	197	2,450	2,634	17.1%
Lower Zone West Plant Area				
	49	1,500	402	2.6%
TOTAL	1,538	1,831.7	15,359	100.0%
			33,791	lb/day

ARSENIC

	Q (gpm)	Mean As (mg/L)	As Load (kg/day)	Fraction of Total Load
Upper Zone East Plant Area 1				
	50	0.470	0.128	5.2%
Upper Zone East Plant Area 2				
	52	0.300	0.084	3.4%
Upper Zone East Plant Area 3				
	49	0.150	0.040	1.6%
Upper Zone Central Plant Area				
Stack	126	0.300	0.206	8.4%
340	4	0.300	0.006	0.3%
335s	10	0.300	0.016	0.6%
			0.228	9.3%
Upper Zone West Plant Area				
	104	0.110	0.062	2.5%
Upper Zone FMC				
	187	0.100	0.102	4.2%
Lower Zone East Plant Area 1				
	562	0.400	1.225	50.0%
Lower Zone East Plant Area 2				
	147	0.250	0.200	8.2%
Lower Zone Central Plant Area				
	197	0.310	0.333	13.6%
Lower Zone West Plant Area				
	49	0.180	0.048	2.0%
TOTAL	1,538	0.292	2.451	100.0%
			5.39	lb/day

Table 5: Estimated mass removal rate by production well SWP-4

METHOD:

The plant production wells were operating at the time that the river data were being collected. Chemical analysis of groundwater collected from well SWP-4 indicates that the well is extracting stack-affected groundwater. Mass removal rates are as follows:

Mex = Qex * Cex

where:

- Mex = Mass extraction rate
- Qex = Pumping rate at SWP-4
- Cex = Average concentration discharge water

Some of the mass removed is contributed by stack-affected groundwater and the remaining mass is contributed by unaffected groundwater (background). By assuming concentrations for both stack-affected groundwater and background in groundwater, the flow rate of stack-affected groundwater contributing to the flow in SWP-4 can be calculated as follows:

Qs = (Qex*Cex - Qb*Cb) / Cs

where:

- Qs = Flow of stack-affected groundwater to SWP-4
- Qex = Discharge rate at SWP-4
- Qb = Flow of groundwater at background concentration to SWP-4
- Cs = Concentration in stack-affected groundwater
- Cex = Concentration in discharge from SWP-4
- Cb = Background concentration in groundwater

RESULTS: 2000

Average Extraction Rate (gpm)	Average Sulfate (mg/L)	Sulfate Load (kg/day)	Average Arsenic (mg/L)	Arsenic Load (kg/day)	Average OPhos (mg/L)	OPhos Load (kg/day)
1464	360.1	2869.58	0.048	0.383	10.76	85.74

SULFATE

	Flow (gpm)	Conc (mg/L)	Load (kg/d)
Stack	185	2450	2472.76
Background	1279	57	396.83
Total	1464		2869.58

ARSENIC

	Flow (gpm)	Conc (mg/L)	Load (kg/d)
Stack	185	0.310	0.313
Background	1279	0.01	0.070
Total	1464		0.383

ORTHOPHOSPHATE

	Flow (gpm)	Conc (mg/L)	Load (kg/d)
Stack	185	85	85.61
Background	1279	0.02	0.14
Total	1464		85.74

Captured Stack Flow = 185 gpm

Fraction of Total Flow = 12.7%

RESULTS: 2008

Average Extraction Rate (gpm)	Average Sulfate (mg/L)	Sulfate Load (kg/day)	Average Arsenic (mg/L)	Arsenic Load (kg/day)	Average OPhos (mg/L)	OPhos Load (kg/day)
845	163.75	753.17	0.018325	0.084	2.78	12.79

SULFATE

	Flow (gpm)	Conc (mg/L	Load (kg/d)
Stack	37	2500	502.48
Background	808	57	250.69
Total	845		753.17

ARSENIC

	Flow (gpm)	Conc (mg/L	Load (kg/d)
Stack	37	0.200	0.040
Background	810	0.01	0.044
Total	847		0.084

ORTHOPHOSPHATE

	Flow (gpm)	Conc (mg/L	Load (kg/d)
Stack	37	85	12.70
Background	810	0.02	0.09
Total	847		12.79

Captured Stack Flow = 37 gpm

Fraction of Total Flow = 4.4%

Table 6: Estimate Attenuation In Stack-Affected Groundwater

METHOD:
1. Estimate mass flux of constituent in groundwater downgradient of the source areas and SWP-4.
2. Account for attenuation of constituent associated with low pH groundwater.
3. Estimate mass flux of constituent measured in the river downgradient of Site.
4. Estimate the mass flux of constituent in the river that comes from background sources (upstream river and groundwater).
5. Estimate the constituent mass flux in the river from the source area.
6. Compare mass flux downgradient of source to site related flux in the river to estimate percent of constituent attenuated.

RESULTS:

Orthophosphate

1. Estimate mass flux of orthophosphate in groundwater downgradient of the source areas and SWP-4

Total Mass flux	1,176	kg/day
Subtract Mass Removed by SWP-4	86	kg/day
Net Mass Flux	1,090	kg/day

2. Estimate mass flux of orthophosphate removed by attentuation of low pH groundwater

Mass flux of orthophosphate in low pH groundwater	253	
Attenuation rate	90%	
Mass flux removed by attenuation	228	kg/day

3. Estimate mass flux of orthophosphate measured in the river downgradient of Site

Flow and concentration measured during the TMDL (see Table 2)

Mass flux in the river at transect T3	543	kg/day

4. Estimate the mass flux of groundwater from background sources (upstream river and groundwater)

Upstream flow and concentration measured during the TMDL (see Table 2)

Mass flux in river at transect T1	2	kg/day

Groundwater inflow calculated from TMDL data (see Table 2).

Total Groundwater Inflow	68	cfs
Flow Impacted by Sources	4	cfs
Unimpacted Groundwater Flow	64	cfs
Unimpacted Groundwater Orthophosphate Concentration	0.080	mg/L
Mass Flux to River from Background Groundwater	13	kg/day
Total Mass Flux in River From Background Sources	15	kg/day

5. Estimate the mass flux in the river from the source area (total minus background)

Mass flux from source area	529	kg/day

6. Compare source-related mass flux in river to mass flux in groundwater at the sources

Mass flux in groundwater at the sources	862	kg/day
Source-related mass flux in the river	529	kg/day
Estimated mass flux lost to attenuation	334	kg/day
Percentage lost	39%	

Sulfate

1. Estimate mass flux of sulfate in groundwater downgradient of the source areas and SWP-4

Total Mass flux	15,190	kg/day
Subtract Mass Removed by SWP-4	2,870	kg/day
Net Mass Flux	12,320	kg/day

2. Estimate mass flux of sulfate removed by attentuation of low pH groundwater

Mass flux of sulfate in low pH groundwater	170	
Attenuation rate	90%	
Mass flux removed by attenuation	153	kg/day

3. Estimate mass flux of sulfate measured in the river downgradient of Site

Flow and concentration measured during the TMDL (see Table 2)

Mass flux in the river at transect T3	26,213	kg/day

4. Estimate the mass flux of groundwater from background sources (upstream river and groundwater)

Upstream flow and concentration measured during the TMDL (see Table 2)

Mass flux in river at transect T1	7,545	kg/day

Groundwater inflow calculated from TMDL data (see Table 2).

Total Groundwater Inflow	68	cfs
Flow Impacted by Sources	4	cfs
Unimpacted Groundwater Flow	64	cfs
Unimpacted Groundwater Sulfate Concentration	57	mg/L
Mass Flux to River from Background Groundwater	8,959	kg/day
Total Mass Flux in River From Background Sources	16,504	kg/day

5. Estimate the mass flux in the river from the source area (total minus background)

Mass flux from source area	9,709	kg/day

6. Compare source-related mass flux in river to mass flux in groundwater at the sources

Mass flux in groundwater at the sources	12,167	kg/day
Source-related mass flux in the river	9,709	kg/day
Estimated mass flux lost to attenuation	2,458	kg/day
Percentage lost	20%	

Table 7: Model for Estimating Concentrations in Groundwater at River

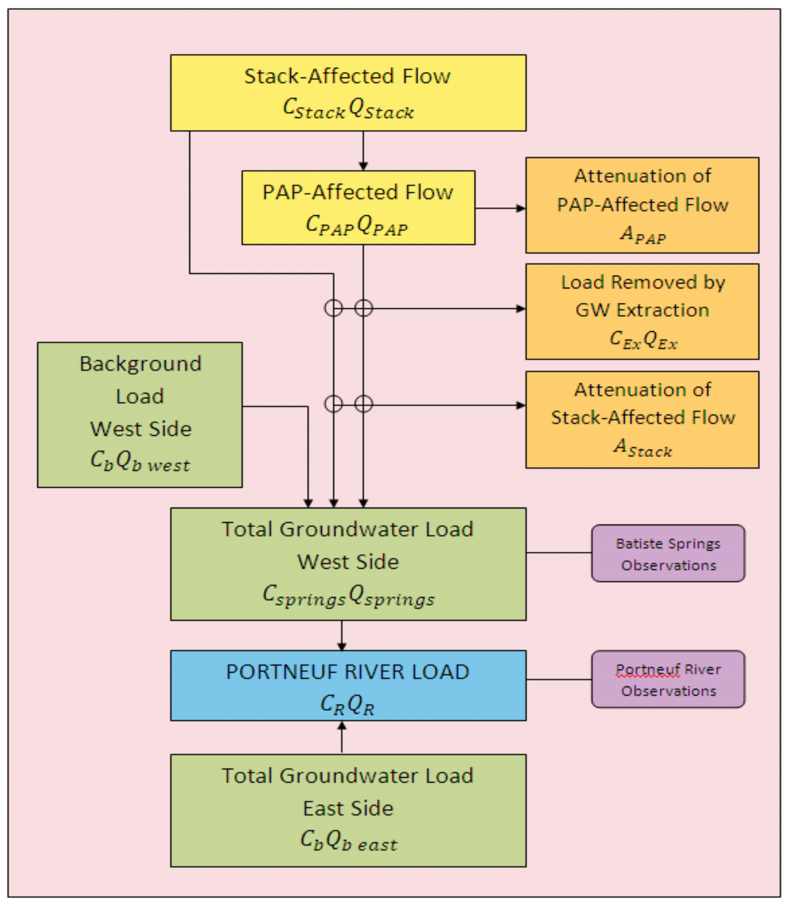
METHOD:
The estimated concentrations of COCs in source-affected groundwater at the point of discharge along the west bank of the river (in the vicinity of Batiste Springs) is calculated in two steps: 1) calculate attenuation losses that occur in groundwater between the gypsum stack and the river, and 2) estimate the fraction of the contribution to the river that originates from the west side bank and calculate the resulting concentration in the west side groundwater.

The basic mass balance equation from groundwater between the source and the river is:

$$(C_{Stack} * Q_{Stack}) + (C_{PAP} * Q_{PAP}) + (C_b * Q_{b\ west}) - (C_{Ex} * Q_{Ex}) - A_{Stack} - A_{PAP} = (C_{springs} * Q_{springs})$$

where:

See diagram below



Some of the parameters are estimated (as shown in previous tables) and some are directly measured. As a reality check the mass balance is solved for concentration at the springsand compared to actual measurements.

The algebraic solution of the mass balance for the springs concentration is:

$$\boxed{C_{springs} = [(C_{Stack} * Q_{Stack}) + (C_{PAP} * Q_{PAP}) + (C_b * Q_{b\ west}) - (C_{Ex} * Q_{Ex}) - A_{Stack} - A_{PAP}] /\ Q_{springs}}$$

Pre-CERCLA Conditions

Parameter	**Groundwater Flow**		
Q_{Stack}	Flow of stack-affected groundwater in Plant Area	3.3	cfs
Q_{PAP}	Flow of PAP-affected groundwater (low pH)	0.3	cfs
Q_{Ex}	Flow stack affected groundwater from SWP-4	0.4	cfs
Q_b	Flow of unaffected groundwater discharging to west side of river	30.5	cfs
$Q_{springs}$	Total groundwater flow discharging to west side of river	33.9	cfs

	Mass Flux	**Arsenic**		**Sulfate**		**Orthophosphate**	
$C_{Stack} * Q_{Stack}$	Mass in groundwater down gradient of stack sources	2.429	kg/day	15,190	kg/day	923	kg/day
$C_{PAP} * Q_{PAP}$	Mass contributed from low pH sources in PAP	0.022	kg/day	170	kg/day	253	kg/day
A_{PAP}	Attenuation of uncaptured PAP flow	-	kg/day	153	kg/day	228	kg/day
$C_{ex} * Q_{ex}$	Mass Removed by SWP-4	0.313	kg/day	2,473	kg/day	86	kg/day
A_{Stack}	Attenuation of Stack flow	-	kg/day	2,604	kg/day	334	kg/day
$C_b * Q_b$	Mass in unaffected groundwater	0.291	kg/day	4,252	kg/day	6.0	kg/day
	Net mass discharging to river from west side groundwater	2.429	kg/day	14,382	kg/day	535	kg/day
	Concentrations at Discharge						
C_b	Local groundwater concentration	0.0039	mg/L	57	mg/L	0.08	mg/L
$C_{springs}$	Estimated average concentration in groundwater at discharge	0.0293	mg/L	173	mg/L	6.44	mg/L

Conditions in 2008 (if no CERCLA extraction)

Parameter	**Groundwater Flow**		
Q_{Stack}	Flow of stack-affected groundwater in Plant Area	3.3	cfs
Q_{PAP}	Flow of PAP-affected groundwater (low pH)	0.3	
Q_{Ex}	Flow stack affected groundwater from SWP-4	0.1	
Q_b	Flow of unaffected groundwater discharging to west side of river	30.5	cfs
$Q_{springs}$	Total groundwater flow discharging to west side of river	34.2	cfs

	Mass Flux	**Arsenic**		**Sulfate**		**Orthophosphate**	
$C_{Stack} * Q_{Stack}$	Mass in groundwater down gradient of stack sources	2.36	kg/day	16,942	kg/day	1,340	kg/day
$C_{PAP} * Q_{PAP}$	Mass contributed from low pH sources in PAP	0.03	kg/day	117	kg/day	496	kg/day
A_{PAP}	Attenuation of uncaptured PAP flow	-	kg/day	106	kg/day	446	kg/day
$C_{ex} * Q_{ex}$	Mass Removed by SWP-4	0.04	kg/day	502	kg/day	13	kg/day
A_{Stack}	Attenuation of Stack flow	-	kg/day	3,322	kg/day	341	kg/day
$C_b * Q_b$	Mass in unaffected groundwater	0.291	kg/day	4,252	kg/day	6.0	kg/day
	Net mass discharging to river from west side groundwater	2.62	kg/day	17,381	kg/day	1,042	kg/day
	Concentrations at Discharge						
C_b	Local groundwater concentration	0.0039	mg/L	57	mg/L	0.08	mg/L
$C_{springs}$	Estimated average concentration in groundwater at discharge	0.0313	mg/L	208	mg/L	12.47	mg/L

Table 8: Estimate of Load Reduction Required to Meet MCL at Springs, pre-CERCLA Extraction System

METHOD:
The effect of the extraction of stack-affected groundwater is assessed by calculating the flow, concentration, and resulting mass load that can be removed by extraction wells, then calculating the effect that uncaptured flow has on downgradient concentrations. The well configuration is varied iteratively until the predicted concentration at the springs meets the remedial goal. The same equation as Table 6 is used:

$$C_{springs} = [(C_{Stack} * Q_{Stack}) + (C_{PAP} * Q_{PAP}) + (C_b * Q_{b\ west}) - (C_{Ex} * Q_{Ex}) - A_{Stack} - A_{PAP}]\ /\ Q_{springs}$$

The following assumptions are made in making the above calculation:

1. The load lost to attenuation of stack-affected groundwater (A_{Stack}) is assumed to be the same percentage as calculated for the flow and mass balance.
2. The load lost to attenuation of PAP-affected groundwater (A_{PAP}) is only for uncaptured low pH sources and is assumed to be 90% of the total low pH load.
3. Concentrations of extracted groundwater are estimated at the point of extraction and are typically higher than the average concentrations estimated for the entire region.
4. The effect of SWP-4 is included as an extraction well
5. Mass flux is assessed north of the PAP Area for the Central Plant UZ and includes both low pH PAP affected and Stack affected groundwater.

RESULTS:

Parameter	Description	Arsenic	Sulfate	Phos	
$C_{Stack} * Q_{Stack}$	Mass Flux in Groundwater Downgradient of Stack (Table 4)	2.43	15,190	923	kg/day
$C_{PAP} * Q_{PAP}$	Mass Flux in Groundwater Downgradient of PAP (Table 4)	0.022	170	253	kg/day
$C_{ex} * Q_{ex}$	Mass flux extracted (see below)	0.312	2,467	86	kg/day
A_{PAP}	Attenuation of Uncaptured PAP-Affected Groundwater	0	153	228	kg/day
A_{Stack}	Attenuation of Stack-Affected Groundwater (Table 6)	0	2,574	334	kg/day
Q_b	Background Flow (Table 1)	30.5	30.5	30.5	cfs
C_b	Background concentration (Table 2)	0.0039	57	0.08	mg/L
$C_b * Q_b$	Mass Flux in Background Groundwater	0.291	4,250	6.0	kg/day
$Q_{springs}$	Total west side groundwater discharge (Table 1 minus extracted)	33.9	33.9	33.9	cfs
	Estimated Constituent Concentrations in the Springs at the River	0.0293	173.7	6.443	mg/L

Orthophosphate

Flow Rate (gpm)	Mean P (mg/L)	P Load per well (kg/day)	Wells	Total Flow (gpm)	Uncaptured Flow (gpm)	Load Removed (kg/day)	Load Passed (kg/day)
East Plant UZ Area 1							
15	200	16		-	50	-	27
East Plant UZ Area 2							
25	300	41	-	-	52	-	56
East Plant UZ Area 3							
30	200	33	-	-	49	-	13
Central Plant UZ							
40	500	109	-	-	126	-	322
West Plant UZ							
30	15	2	-	-	104	-	10
FMC UZ							
200	25	27	-	-	187	-	5
East Plant LZ Area 1							
130	300	212		-	562	-	524
East Plant LZ Area 2							
130	150	106	-	-	124	-	120
Central Plant LZ							
185	85	86	1	185	-	86	6
West Plant LZ							
50	10	3	-	-	49	-	7
		Total	1	185	1,305	86	1,090

Mass Flux Removed at Well Line 7%

Sulfate

Flow Rate (gpm)	Mean SO4 (mg/L)	SO4 Load per well (kg/day)	Wells	Total Flow (gpm)	Uncaptured Flow (gpm)	Load Removed (kg/day)	Load Passed (kg/day)
East Plant UZ Area 1							
15	3000	245	-	-	50	-	736
East Plant UZ Area 2							
25	3000	408	-	-	52	-	758
East Plant UZ Area 3							
30	3000	490	-	-	49	-	507
Central Plant UZ							
40	2000	435	-	-	126	-	1,407
West Plant UZ							
30	1500	245	-	-	104	-	425
FMC UZ							
200	1500	1,633	-	-	187	-	765
East Plant LZ Area 1							
130	2700	1,911	-	-	562	-	6,123
East Plant LZ Area 2							
130	2700	1,911	-	-	124	-	1,602
Central Plant LZ							
185	2450	2,467	1	185	-	2,467	166
West Plant LZ							
50	1200	327	-	-	49	-	402
		Total	1	185	1,305	2,467	12,892

Mass Flux Removed at Well Line 16%

Arsenic

Flow Rate (gpm)	Mean As (mg/L)	As Load per well (kg/day)	Wells	Total Flow (gpm)	Uncaptured Flow (gpm)	Load Removed (kg/day)	Load Passed (kg/day)
East Plant UZ Area 1							
15	0.550	0.04	-	-	50.07	-	0.13
East Plant UZ Area 2							
25	0.400	0.05	-	-	51.58	-	0.08
East Plant UZ Area 3							
30	0.350	0.06	-	-	49.04	-	0.04
Central Plant UZ							
40	0.400	0.09	-	-	126.33	-	0.23
West Plant UZ							
30	0.300	0.05	-	-	104.22	-	0.06
FMC UZ							
200	0.300	0.33	0	-	187.35	-	0.10
East Plant LZ Area 1							
130	0.450	0.32	-	-	562.44	-	1.22
East Plant LZ Area 2							
130	0.350	0.25	-	-	124.31	-	0.20
Central Plant LZ							
185	0.310	0.31	1	185	-	0.31	0.02
West Plant LZ							
50	0.100	0.03	-	-	49.26	-	0.05
		Total	1	185	1,304.61	0.31	2.14

Mass Flux Removed at Well Line 13%

Table 9: Estimate of Load Reduction Required to Meet MCL at Springs, Status with Phase 2 Extraction system

METHOD:
The effect of the extraction of stack-affected groundwater is assessed by calculating the flow, concentration, and resulting mass load that can be removed by extraction wells, then calculating the effect that uncaptured flow has on downgradient concentrat

$$C_{springs} = [(C_{Stack} * Q_{Stack}) + (C_{PAP} * Q_{PAP}) + (C_b * Q_{b\ west}) - (C_{Ex} * Q_{Ex}) - A_{Stack} - A_{PAP}] / Q_{springs}$$

The following assumptions are made in making the above calculation:

1. The load lost to attenuation of stack-affected groundwater (A_{Stack}) is assumed to be the same percentage as calculated for the flow and mass balance.
2. The load lost to attenuation of PAP-affected groundwater (A_{PAP}) is only for uncaptured low pH sources and is assumed to be 90% of the total low pH load.
3. Concentrations of extracted groundwater are estimated at the point of extraction and are typically higher than the average concentrations estimated for the entire region.
4. The effect of SWP-4 is included as an extraction well
5. Mass flux is assessed north of the PAP Area for the Central Plant UZ and includes both low pH PAP affected and Stack affected groundwater.

RESULTS:

Parameter	Description	Arsenic	Sulfate	Phos	
$C_{Stack} * Q_{Stack}$	Mass Flux in Groundwater Downgradient of Stack (Table 4)	2.36	16,942	1,340	kg/day
$C_{PAP} * Q_{PAP}$	Mass Flux in Groundwater Downgradient of PAP (Table 4)	0.029	117	496	kg/day
$C_{ex} * Q_{ex}$	Mass flux extracted (see below)	1.66	14,129	1,110	kg/day
A_{PAP}	Attenuation of Uncaptured PAP-Affected Groundwater	0	106	446	kg/day
A_{Stack}	Attenuation of Stack-Affected Groundwater (Table 6)	0	571	108	kg/day
Q_b	Background Flow (Table 1)	30.5	30.5	30.5	cfs
C_b	Background concentration (Table 2)	0.0039	57	0.08	mg/L
$C_b * Q_b$	Mass Flux in Background Groundwater	0.291	4,250	6.0	kg/day
$Q_{springs}$	Total west side groundwater discharge (Table 1 minus extracted)	32.2	32.2	32.2	cfs
	Estimated Constituent Concentrations in the Springs at the River	0.0130	82.5	2.255	mg/L

Orthophosphate

Extraction Well	Flow Rate (gpm)	P Removal Conc. (mg/L)	P Load Removed (kg/day)	Total Flow (gpm)	Uncaptured Flow (gpm)	Load Removed (kg/day)	Load Passed (kg/day)
East Plant UZ Area 1							
404	2	172	2				
405	3	510	8				
412	25	168	23				
			33	30	20	33	42
East Plant UZ Area 2							
406	15	610	50				
407	6	530	17				
408	0	410	-				
			67	21	31	67	54
East Plant UZ Area 3							
409	4	410	9				
413	25	256	35				
			44	29	20	44	36
Central Plant UZ							
414	30	122	20				
			20	30	96	20	542
West Plant UZ							
401	17	159	15				
402	20	129	14				
415	25	44	6				
			35	-	104	35	0
FMC UZ							
	0	85	-	-	187	-	3
East Plant LZ Area 1							
410	100	330	180				
411	80	390	170				
412	375	168	343				
			692	555	87	692	42
East Plant LZ Area 2							
413	100	256	139				
			139	100	47	133	-
Central Plant LZ							
	185	85	86	185	-	86	2
West Plant LZ							
415	25	44	6				
		44	6	25	24	5	-
			Total	950	593	1,110	721

Mass Flux Removed at Well Line 61%

Sulfate

Extraction Well	Flow Rate (gpm)	SO4 Removal Conc. (mg/L)	SO4 Load Removed (kg/day)	Total Flow (gpm)	Uncaptured Flow (gpm)	Load Removed (kg/day)	Load Passed (kg/day)
East Plant UZ Area 1							
404	2	2980	32				
405	3	3360	55				
412	25	2260	308				
			395	30	20	395	343
East Plant UZ Area 2							
406	15	3260	266				
407	6	3330	109				
408	0	3190	-				
			375	21	31	375	465
East Plant UZ Area 3							
409	4	3140	68				
413	25	2950	401				
			470	29	20	470	60
Central Plant UZ							
414	30	2300	376				
			376	30	96	376	749
West Plant UZ							
401	17	2790	258				
402	20	2890	315				
415	25	1660	226				
			799	-	104	799	106
FMC UZ							
	0	2000	-	-	187	-	292
East Plant LZ Area 1							
410	100	3080	1,677				
411	80	3050	1,328				
412	375	2260	4,613				
			7,618	555	87	7,618	543
East Plant LZ Area 2							
413	100	2950	1,606				
			1,606	100	47	1,575	-
Central Plant LZ							
	185.4218	2500	2,523	185	-	2,523	51
West Plant LZ							
415	25	1660	226				
		1660	226	25	24	226	96
			Total	950	593	14,129	2,608

Mass Flux Removed at Well Line 84%

Arsenic

Extraction Well	Flow Rate (gpm)	As Removal Conc. (mg/L)	As Load Removed (kg/day)	Total Flow (gpm)	Uncaptured Flow (gpm)	Load Removed (kg/day)	Load Passed (kg/day)
East Plant UZ Area 1							
404	2	0.529	0.01				
405	3	0.366	0.01				
412	25	0.267	0.04				
			0.05	30	20.07	0.05	0.08
East Plant UZ Area 2							
406	15	0.322	0.03				
407	6	0.320	0.01				
408	0	0.329	-				
			0.04	21	30.58	0.04	0.05
East Plant UZ Area 3							
409	4	0.335	0.01				
413	25	0.325	0.04				
			0.05	29	20.04	0.05	0.02
Central Plant UZ							
414	30	0.346	0.06				
			0.06	30	96.33	0.06	0.12
West Plant UZ							
401	17	0.433	0.04				
402	20	0.386	0.04				
415	25	0.255	0.03				
			0.12	62	42.22	0.12	0.02
FMC UZ							
	0	0.350	-	-	187.35	-	0.09
East Plant LZ Area 1							
410	100	0.349	0.19				
411	80	0.304	0.13				
412	375	0.267	0.55				
			0.87	555	87.32	0.87	0.27
East Plant LZ Area 2							
413	100	0.325	0.18				
			0.18	100	47.13	0.17	-
Central Plant LZ							
	185.4218	0.310	0.31	185	-	0.31	0.05
West Plant LZ							
415	25	0.255	0.03				
		0.255	0.03	25	24.26	0.03	0.01
			Total	1,012	531.05	1.66	0.70

Mass Flux Removed at Well Line 70%

Table 10: Estimate of Load Reduction Required to Meet MCL at Springs, with Final Extraction System

METHOD:

The effect of the extraction of stack-affected groundwater is assessed by calculating the flow, concentration, and resulting mass load that can be removed by extraction wells, then calculating the effect that uncaptured flow has on downgradient concentrat

$$C_{springs} = [(C_{Stack} * Q_{Stack}) + (C_{PAP} * Q_{PAP}) + (C_b * Q_{b\ west}) - (C_{Ex} * Q_{Ex}) - A_{Stack} - A_{PAP}] / Q_{springs}$$

The following assumptions are made in making the above calculation:

1. The load lost to attenuation of stack-affected groundwater (A_{Stack}) is assumed to be the same percentage as calculated for the flow and mass balance.
2. The load lost to attenuation of PAP-affected groundwater (A_{PAP}) is only for uncaptured low pH sources and is assumed to be 90% of the total low pH load.
3. Concentrations of extracted groundwater are estimated at the point of extraction and are typically higher than the average concentrations estimated for the entire region.
4. The effect of SWP-4 is included as an extraction well
5. Mass flux is assessed north of the PAP Area for the Central Plant UZ and includes both low pH PAP affected and Stack affected groundwater.

RESULTS:

Parameter	Description	Arsenic	Sulfate	Phos	
$C_{Stack} * Q_{Stack}$	Mass Flux in Groundwater Downgradient of Stack (Table 4)	2.36	16,942	1,340	kg/day
$C_{PAP} * Q_{PAP}$	Mass Flux in Groundwater Downgradient of PAP (Table 4)	0.029	117	496	kg/day
$C_{ex} * Q_{ex}$	Mass flux extracted (see below)	1.96	15,416	1,701	kg/day
A_{PAP}	Attenuation of Uncaptured PAP-Affected Groundwater	0	0	0	kg/day
A_{Stack}	Attenuation of Stack-Affected Groundwater (Table 6)	0	332	52	kg/day
Q_b	Background Flow (Table 1)	30.5	30.5	30.5	cfs
C_b	Background concentration (Table 2)	0.0039	57	0.08	mg/L
$C_b * Q_b$	Mass Flux in Background Groundwater	0.291	4,250	6.0	kg/day
$Q_{springs}$	Total west side groundwater discharge (Table 1 minus extracted)	31.6	31.6	31.6	cfs
	Estimated Constituent Concentrations in the Springs at the River	0.0094	71.9	1.145	mg/L

Orthophosphate

Extraction Well	Flow Rate (gpm)	P Removal Conc. (mg/L)	P Load Removed (kg/day)	Total Flow (gpm)	Uncaptured Flow (gpm)	Load Removed (kg/day)	Load Passed (kg/day)
East Plant UZ Area 1							
404	2	172	1.87				
405	3	510	8.33				
412	25	168	22.86				
			33.06	30	20	33	42
East Plant UZ Area 2							
406	15	610	49.81				
407	6	530	17.31				
408	0	410	-				
E-2	20	450	48.99				
			116.10	41	11	116	5
East Plant UZ Area 3							
409	4	410	8.93				
413	25	256	34.84				
E-3	20	276	30.05				
			73.81	49	0	74	6
Central Plant UZ							
414	25	122	16.60				
416	35	113	21.53				
419	35	2435	463.90				
			502.03	95	31	502	60
West Plant UZ							
401	40	159	34.62				
402	20	129	14.04				
415	25	44	5.99				
			54.65	-	104	35	-
FMC UZ							
	0	85	-	-	187	-	3
East Plant LZ Area 1							
410	0	330	-				
E-2	150	250	204.12				
411	80	390	169.83				
412	375	168	342.92				
			716.87	605	37	717	17
East Plant LZ Area 2							
413	100	256	139.35				
E-3	80	350	152.41				
			291.76	180	-	133	-
Central Plant LZ							
	185	85	85.79	185	-	86	2
West Plant LZ							
415	25	44	5.99				
		44	5.99	25	24	5	-
			Total	1,210	415	1,701	135

Mass Flux Removed at Well Line 93%

Sulfate

Extraction Well	Flow Rate (gpm)	SO4 Removal Conc. (mg/L)	SO4 Load Removed (kg/day)	Total Flow (gpm)	Uncaptured Flow (gpm)	Load Removed (kg/day)	Load Passed (kg/day)
East Plant UZ Area 1							
404	2	2980	32				
405	3	3360	55				
412	25	2260	308				
			395	30	20	395	343
East Plant UZ Area 2							
406	15	3260	266				
407	6	3330	109				
408	0	3190	-				
E-2	20	3260	355				
			730	41	11	730	110
East Plant UZ Area 3							
409	4	3140	68				
413	25	2950	401				
E-3	20	2500	272				
			742	49	0	530	-
Central Plant UZ							
414	25	2300	313				
416	35	1860	354				
419	35	1530	291				
			959	95	31	959	166
West Plant UZ							
401	40	2790	607				
402	20	2890	315				
415	25	1660	226				
			1,148	-	104	905	-
FMC UZ							
	0	2000	-	-	187	-	292
East Plant LZ Area 1							
410	0	3080	-				
E-2	150	2000	1,633				
411	80	3050	1,328				
412	375	2260	4,613				
			7,574	605	37	7,574	586
East Plant LZ Area 2							
413	100	2950	1,606				
E-3	80	2500	1,089				
			2,694	180	-	1,575	-
Central Plant LZ							
	185	2500	2,523	185	-	2,523	51
West Plant LZ							
415	25	1660	226				
		1660	226	25	24	226	96
			Total	1,210	415	15,416	1,643

Mass Flux Removed at Well Line 90%

Arsenic

Extraction Well	Flow Rate (gpm)	As Removal Conc. (mg/L)	As Load Removed (kg/day)	Total Flow (gpm)	Uncaptured Flow (gpm)	Load Removed (kg/day)	Load Passed (kg/day)
East Plant UZ Area 1							
404	2	0.529	0.0058				
405	3	0.366	0.0060				
412	25	0.267	0.0363				
			0.0481	30	20.07	0.05	0.08
East Plant UZ Area 2							
406	15	0.322	0.0263				
407	6	0.320	0.01				
408	0	0.329	-				
E-2	20	0.322	0.0351				
			0.07	41	10.58	0.07	0.01
East Plant UZ Area 3							
409	4	0.335	0.01				
413	25	0.325	0.04				
E-3	20	0.325	0.04				
			0.09	49	0.04	0.07	-
Central Plant UZ							
414	25	0.346	0.05				
416	35	0.245	0.05				
419	35	0.311	0.06				
			0.15	95	31.33	0.15	0.03
West Plant UZ							
401	40	0.433	0.09				
402	20	0.386	0.04				
415	25	0.255	0.03				
			0.17	85	19.22	0.14	-
FMC UZ							
	0	0.350	-	-	187.35	-	0.09
East Plant LZ Area 1							
410	0	0.349	-				
E-2	150	0.349	0.28				
411	80	0.304	0.13				
412	375	0.267	0.55				
			0.96	605	37.32	0.96	0.17
East Plant LZ Area 2							
413	100	0.325	0.18				
E-3	80	0.300	0.13				
			0.31	180	-	0.17	-
Central Plant LZ							
	185	0.310	0.31	185	-	0.31	0.05
West Plant LZ							
415	25	0.255	0.03				
		0.255	0.03	25	24.26	0.03	0.01
			Total	1,295	330.18	1.96	0.44

Mass Flux Removed at Well Line 82%

APPENDIX C

Groundwater Flow and Capture Calculations

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Groundwater Travel Time Estimation

OBJECTIVE: Estimate groundwater travel time for stack-affected groundwater.

METHOD: The rate of flow of stack affected groundwater from the site is calculated as follows:

$$V_x = K_x * i_x / n_x$$

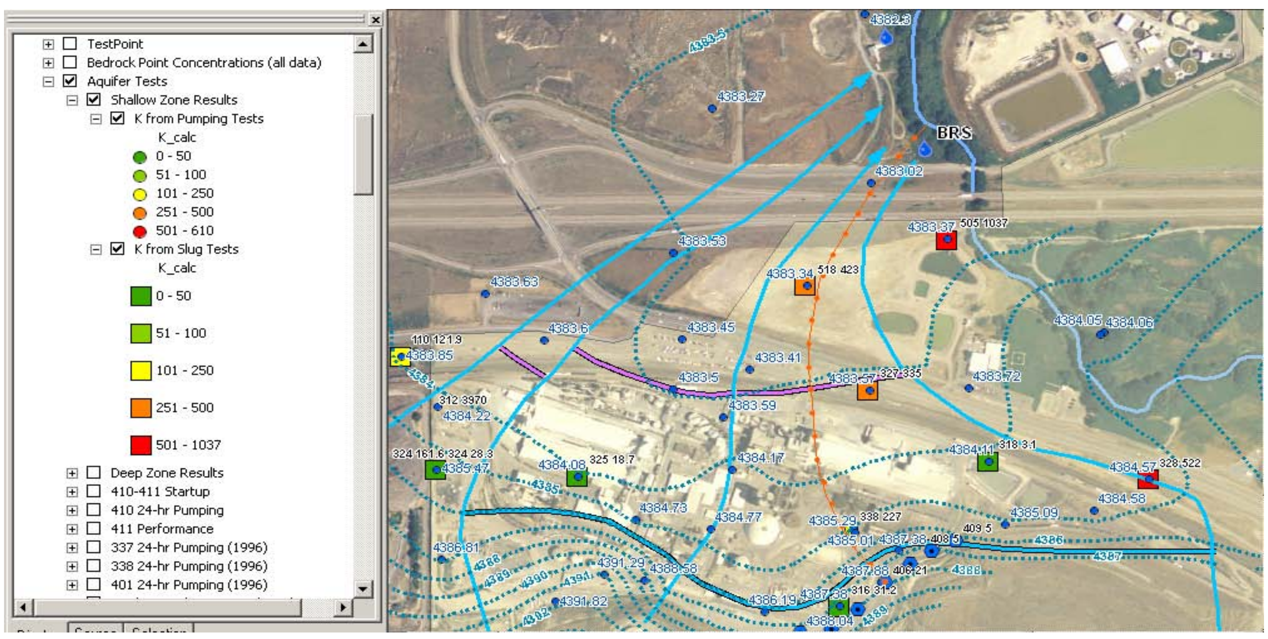
where:

V_x = Groundwater velocity for flow segment x
K_x = Average hydraulic conductivity for segment x
i_x = Average hydraulic gradient for segment x
n_x = Effective porosity for segment x

The following steps are followed in the calculation:

1. The flow path is divided into segments at lines of equipotential
2. Segment length and difference in equipotential used to calculate hydraulic gradient
3. Hydraulic conductivity estimated for segment based on nearby test results (see figure). Hydraulic conductivity adjusted for estimated effects of heterogeneity and anisotropy - vertical hydraulic conductivity is approximately 1/10 that of horizontal hydraulic conductivity.
4. Effective porosity estimated as a function of hydraulic conductivity.

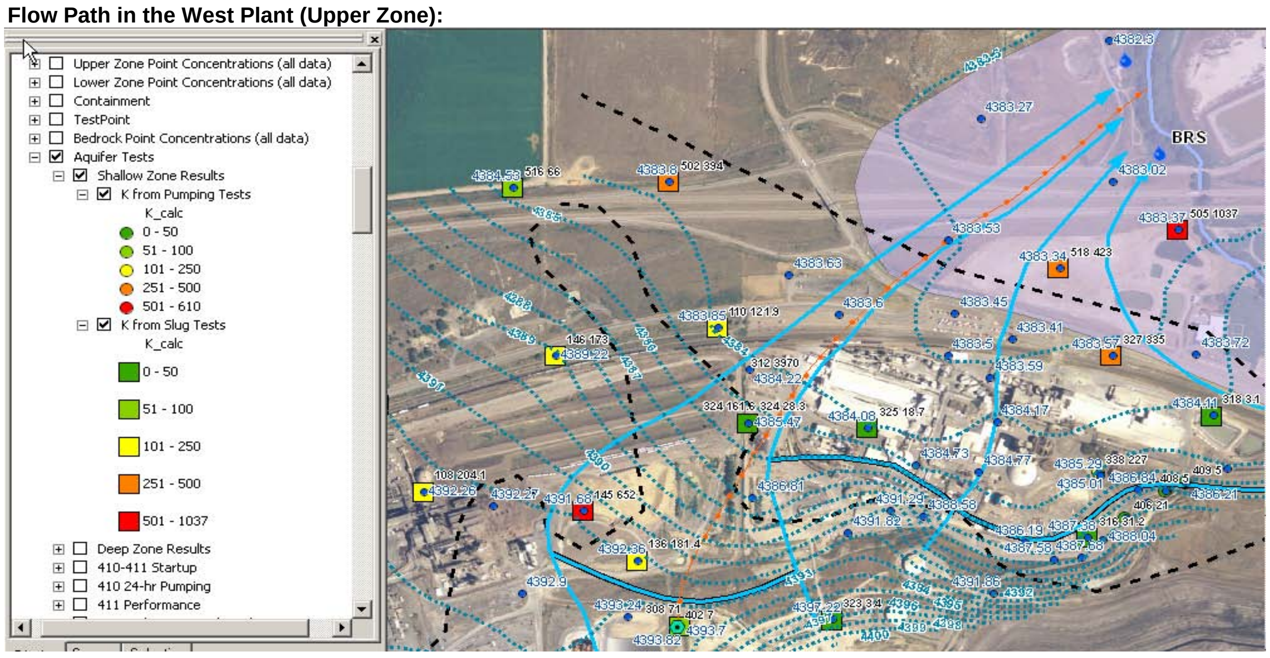
Flow Path in the East Plant Upper Zone:



RESULTS:

Flow Line Distance (ft)	Head (ft)	Incremental Distance (ft)	Incremental Head (ft)	Gradient (ft/ft)	Estimated K (ft/day)	Estimated n	V (ft/day)	t (days)
0	4388							
215	4386	215	2	0.0093	100	0.1	9.30	23
369	4385	154	1	0.0065	250	0.15	10.82	14
664	4384	295	1	0.0034	500	0.25	6.78	44
1230	4383.5	566	0.5	0.0009	500	0.25	1.77	320
2400	4383	1170	0.5	0.0004	1000	0.3	1.42	821
2830	4382.5	430	0.5	0.0012	1000	0.3	3.88	111
		2830						
							Total Travel Time	1333 days
								3.65 years

Flow Path in the West Plant (Upper Zone):



RESULTS:

Flow Line Distance (ft)	Head (ft)	Incremental Distance (ft)	Incremental Head (ft)	Gradient (ft/ft)	Estimated K (ft/day)	Estimated n	V (ft/day)	t (days)
0	4393.7							
990	4387	990	6.7	0.0068	100	0.1	6.77	146
1240	4386	250	1	0.0040	150	0.1	6.00	42
1525	4385	285	1	0.0035	250	0.15	5.85	49
1820	4384	295	1	0.0034	500	0.25	6.78	44
4150	4383	2330	1	0.0004	1000	0.3	1.43	1629
4720	4382.5	570	0.5	0.0009	1000	0.3	2.92	195
		4720						
							Total Travel Time	2104 days
								5.76 years

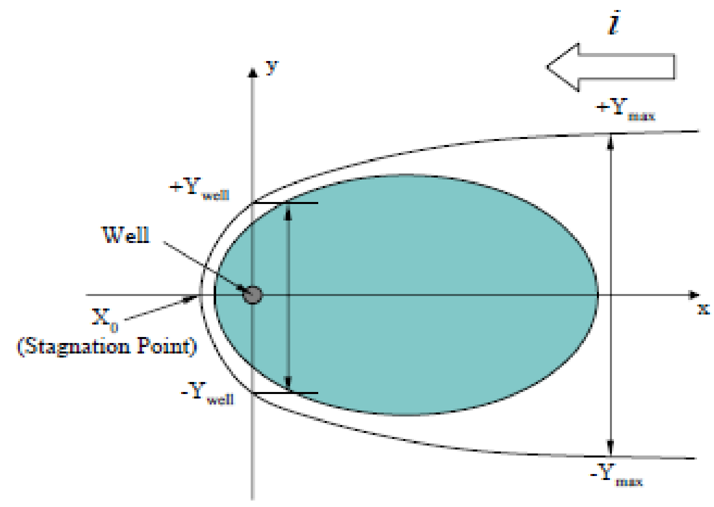
OBJECTIVE: Estimate dimensions of capture zone for an extraction well at steady state pumping.

METHOD:

Capture Zone Width Calculation, One Extraction Well

Assumptions:

- homogeneous, isotropic, confined aquifer of infinite extent
- uniform aquifer thickness
- fully penetrating extraction well(s)
- uniform regional horizontal hydraulic gradient
- steady-state flow
- negligible vertical gradient
- no net recharge, or net recharge is accounted for in regional hydraulic gradient
- no other sources of water introduced to aquifer due to extraction (e.g., from rivers or leakage from above or below)



$$x = \frac{-y}{\tan\left(\frac{2\pi Ti}{Q}y\right)} \qquad -\ or\ - \qquad y = \pm\left(\frac{Q}{2Ti}\right) - \left(\frac{Q}{2\pi Ti}\right)\tan^{-1}\left(\frac{y}{x}\right)$$

$$X_0 = -Q/2\pi Ti \quad ; \quad Y_{max} = \pm Q/2Ti \quad ; \quad Y_{well} = \pm Q/4Ti$$

(must use consistent units, such as "ft" for distance and "day" for time)

Where:

Q	=	extraction rate
T	=	transmissivity, $K \cdot b$
K	=	hydraulic conductivity
b	=	saturated thickness
i	=	regional (i.e., pre-remedy-pumping) hydraulic gradient
X_0	=	distance from the well to the downgradient end of the capture zone along the central line of the flow direction
Y_{max}	=	maximum capture zone width from the central line of the plume
Y_{well}	=	capture zone width at the location of well from the central line of the plume

The above equation is used to calculate the outline of the capture zone. Solving the equation for $x = 0$ allows one to calculate the distance between the dividing streamlines at the line of wells ($2 \cdot Y_{well}$) and solving the equation for $x = \infty$ allows one to calculate the distance between the dividing streamlines far upstream from the wells ($2 \cdot Y_{max}$). One can also calculate the distance from the well to the stagnation point (X_0) that marks the downgradient end of the capture zone by solving for x at $y = 0$. For any value of y between 0 and Y_{max}, one can calculate the corresponding x value, allowing the outline of the capture zone to be calculated.

from Javandel, I. and C.F. Tsang, 1986. Capture-zone type curves: A tool for aquifer cleanup, Ground Water, 24:616-625.

ASSUMPTIONS:

1) homogeneous, isotropic, confined aquifer of infinite extent
2) uniform aquifer thickness
3) fully penetrating extraction well(s)
4) uniform regional hydraulic gradient
5) steady-state flow
6) negligible vertical gradient
7) no net recharge, or net recharge is accounted for in regional hydraulic gradient
8) no other sources of water introduced to aquifer due to ectraction

Analytical Capture Calculations

INPUT:

Zone	Section	Well	Q (gpm)	K (ft/day)	b (ft)	T (sf/day)	i (ft/ft)
UZ	East 1	Well 412	25	200	17.9	7000	0.0038
LZ	East 1	Well 412	475	137	112.7	8900	0.0075
UZ	East 3	Well 413	25	120	15.6	1700	0.0026
LZ	East 3	Well 413	100	115	45.7	6880	0.0034
UZ	Central	Well 414	25	700	50.1	5000	0.000967
LZ	Central	SWP-4	1350	165	78	12870	0.0042
UZ	West	Well 415	25	100	24.3	2800	0.0074
LZ	West	Well 415	25	50	65.2	2800	0.004

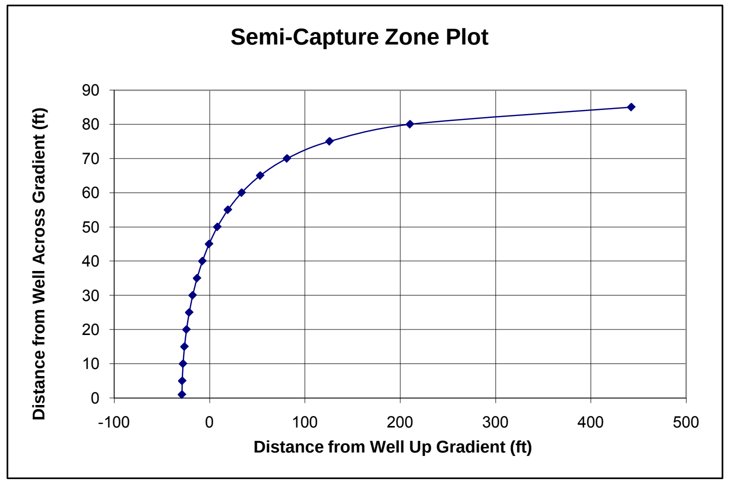
RESULT:

Upper Zone capture zone, East 1 — Well 412

Q = 25 gpm — 4812.834 cfd
K = 200 ft/day
b = 17.9 ft
T = 7000 sf/day
i = 0.0038

Ymax = 90 ft
Ywell = 45 ft
Xo = 29 ft

x	y
-28.7849	1
-28.5065	5
-27.6295	10
-26.1436	15
-24.0102	20
-21.1701	25
-17.5373	30
-12.9894	35
-7.35061	40
-0.36475	45
8.352777	50
19.40352	55
33.78178	60
53.25723	65
81.31818	70
125.9436	75
210.3184	80
442.3467	85

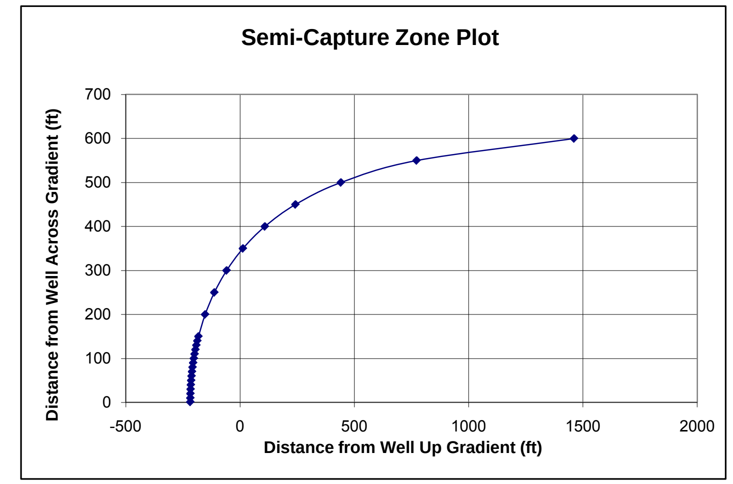


Lower Zone capture zone, East 1 — Well 412

Q = 475 gpm — 91443.85 cfd
K = 137 ft/day
b = 112.7 ft
T = 8900 sf/day
i = 0.0075

Ymax = 685 ft
Ywell = 342 ft
Xo = 218 ft

x	y
-218.032	1
-217.881	10
-217.422	20
-216.656	30
-215.582	40
-214.198	50
-212.502	60
-210.49	70
-208.16	80
-205.507	90
-202.527	100
-199.213	110
-195.561	120
-191.563	130
-187.211	140
-182.498	150
-153.15	200
-112.9	250
-59.2097	300
12.06615	350
108.0308	400
241.823	450
440.6869	500
771.9637	550
1460.81	600

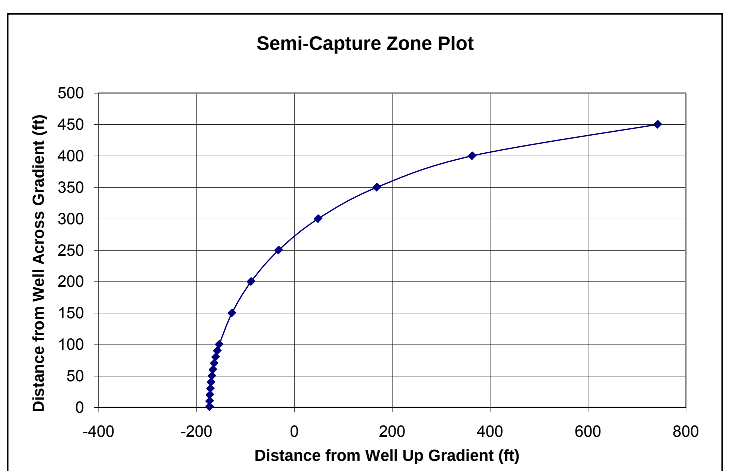


Upper Zone capture zone, East 3 — Well 413

Q = 25 gpm — 4812.834 cfd
K = 120 ft/day
b = 15.6 ft
T = 1700 sf/day
i = 0.0026

Ymax = 544 ft
Ywell = 272 ft
Xo = 173 ft

x	y
-173.298	1
-173.108	10
-172.53	20
-171.566	30
-170.212	40
-168.465	50
-166.32	60
-163.771	70
-160.812	80
-157.433	90
-153.625	100
-127.694	150
-88.5309	200
-32.2298	250
48.50773	300
168.561	350
363.2886	400
742.3715	450

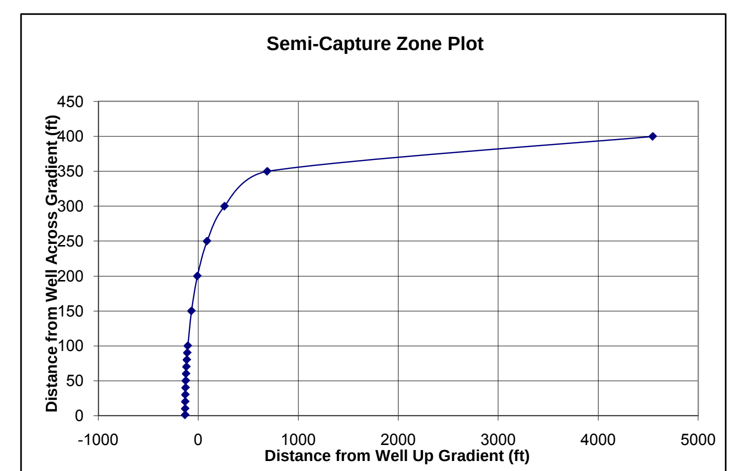


Lower Zone capture zone, East 3 — Well 413

Q = 100 gpm — 19251.34 cfd
K = 115 ft/day
b = 45.7 ft
T = 6880 sf/day
i = 0.0034

Ymax = 411 ft
Ywell = 206 ft
Xo = 131 ft

x	y
-130.98	1
-130.728	10
-129.963	20
-128.684	30
-126.885	40
-124.558	50
-121.69	60
-118.269	70
-114.275	80
-109.69	90
-104.487	100
-67.9971	150
-8.78087	200
87.831	250
262.8996	300
689.9068	350
4546.576	400

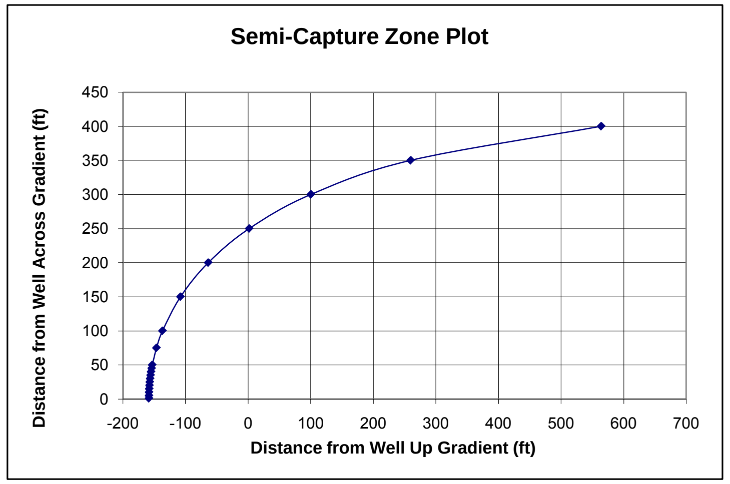


Upper Zone capture zone, Central — Well 414

Q =	25	gpm	4812.834	cfd
K =	700	ft/day		
b =	50.1	ft		
T =	5000	sf/day		
i =	0.000967			

Ymax =	498	ft
Ywell =	249	ft
Xo =	158	ft

x	y
-158.423	1
-158.373	5
-158.215	10
-157.952	15
-157.583	20
-157.108	25
-156.527	30
-155.839	35
-155.044	40
-154.142	45
-153.13	50
-146.409	75
-136.804	100
-107.99	150
-63.7066	200
1.808629	250
100.3635	300
259.7463	350
564.1716	400
1448.889	450

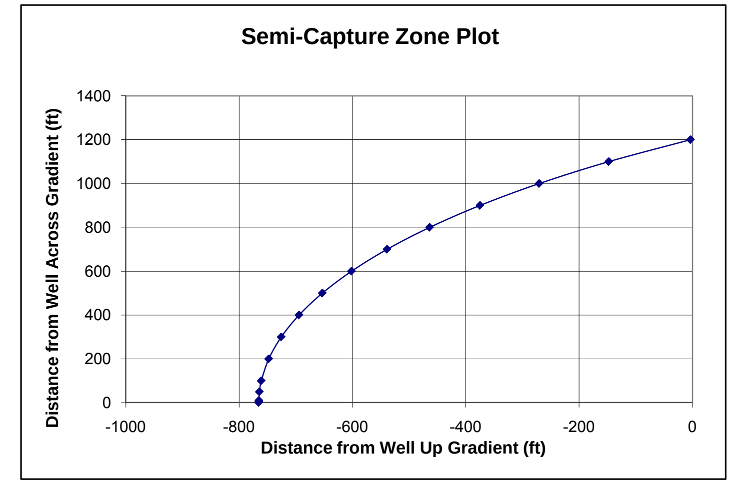


Lower Zone capture zone, Central — Swp-4

Q =	1350	gpm	259893	cfd
K =	165	ft/day		
b =	78	ft		
T =	12870	sf/day		
i =	0.0042			

Ymax =	2404	ft
Ywell =	1202	ft
Xo =	765	ft

x	y
-765.221	1
-765.21	5
-765.178	10
-764.132	50
-760.86	100
-747.717	200
-725.609	300
-694.221	400
-653.089	500
-601.575	600
-538.832	700
-463.747	800
-374.868	900
-270.293	1000
-147.508	1100
-3.14663	1200

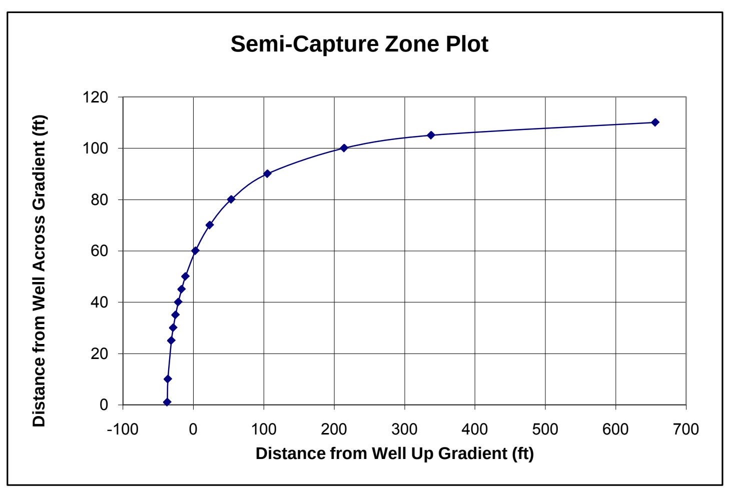


Upper Zone capture zone, West — Well 415

Q =	25	gpm	4812.834	cfd
K =	100	ft/day		
b =	24.3	ft		
T =	2800	sf/day		
i =	0.0074			

Ymax =	116	ft
Ywell =	58	ft
Xo =	37	ft

x	y
-36.9594	1
-36.0624	10
-31.1534	25
-28.4732	30
-25.2011	35
-21.2735	40
-16.6072	45
-11.0913	50
3.135394	60
23.40798	70
53.93728	80
105.3282	90
214.3101	100
337.8404	105
656.2196	110

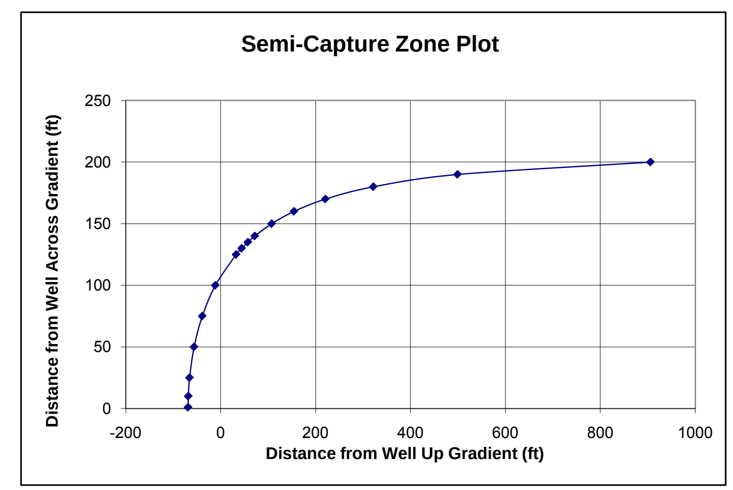


Lower Zone capture zone, West — Well 415

Q =	25	gpm	4812.834	cfd
K =	50	ft/day		
b =	65.2	ft		
T =	2800	sf/day		
i =	0.004			

Ymax =	215	ft
Ywell =	107	ft
Xo =	68	ft

x	y
-68.3868	1
-67.9036	10
-65.318	25
-55.7494	50
-38.4918	75
-10.9059	100
32.83978	125
44.53126	130
57.5757	135
72.21731	140
107.6431	150
154.7349	160
220.9026	170
322.0298	180
499.5061	190
906.0323	200



APPENDIX D

Groundwater Particle Tracking Models

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1.0 METHOD

Three ground water flow models of the site were developed to assist with evaluating groundwater capture zones for existing and proposed pumping wells. The three models are set up as “engineering calculation” type models per the ASTM Standard Guide for Subsurface Flow and Transport Modeling (ASTM 2000). The engineering calculation is a level of fidelity that is appropriate for “applications which are designed to predict the response of the physical hydrogeologic system to a specific change or family of changes in boundary conditions, hydrologic stresses, or aquifer parameters. These applications do not necessarily require a high degree of correspondence between the simulation and the physical hydrogeologic system because aspects of the model which are unrealistic may be designed to be conservative with respect to the intended use”. In this type of model rigorous calibration or inverse modeling efforts are not undertaken.

Groundwater flow modeling was performed using the numerical modeling code MODFLOW (versions 88/96, 2000 or 2005). Pre- and post-processing were performed using Groundwater Vistas. A database of site specific information was developed in Excel and a three-dimensional hydrostratigraphic model was developed with the assistance of Surfer.

The numerical model was developed and evaluated using the following steps:

1. Consult conceptual site model for the site:
    - Review and compile regional and site specific data from previous site works.
    - Develop a three dimensional hydrostratigraphic model for the area of interest.
2. Develop numerical flow model
    - Select the site area of interest
    - Provide adequate horizontal and vertical discretization of model area
    - Set up appropriate boundary conditions
    - Provide parametric estimates that are in line with site investigations
3. Compare results of simulations to observations and make adjustments
    - Compare calculated to observed water levels
    - Compare simulated groundwater flow to other calculated values of groundwater flow
    - Minimize numerical error in the model.
4. Provide particle tracking simulations and evaluate extraction well scenarios
    - Using conditions representative of current pumping system, conduct forward and reverse particle tracking using existing pumping wells.
    - Using conditions representative of current pumping system, evaluate various extraction well scenarios by particle tracking.

2.0 SITE DATA AND CONCEPTUAL SITE MODEL FOR GROUNDWATER

Models were constructed based on the site conceptual model, which is discussed in Section 3.3 of the Groundwater Extraction and Monitoring System Remedial design Report and Remedial Action Work Plan (GWRDR/RAWP) (NewFields 2008) of this report. Aquifer parameters were estimated based on numerous aquifer tests conducted from 1992 to 2008. Aquifer transmissivity was estimated using the curve-matching software, AquiferTest, on results from slug tests, step-drawdown tests and constant rate pumping tests in multiple locations and depths. Aquifer thickness was estimated from cross-sections developed from geologic and lithologic boring logs (see Section 3.3.2 of the GWRDR/RAWP)

3.0 DEVELOPMENT OF NUMERICAL FLOW MODELS

3.1 East Model

3.1.1 Selection of Model Area

The East model area was selected based on target capture zones and the August 2003 steady-state potentiometric surface for both the Upper and Lower Zones. The East model includes the Upper Zone East 1, 2 and 3 target capture zones, and the Lower Zone East 1 and 2 target capture zones. The model extends from approximately the gypsum stack in the south to Highway 86 in the north to maintain boundaries beyond expected zone of influence for the pumping wells. At the southern extent of the model, elevated bedrock causes the termination of the saturated portions of overlying sedimentary layers (i.e. the Upper and Lower Zones terminate, and only the Bedrock Zone is saturated). The East model area is shown in Figure A1..

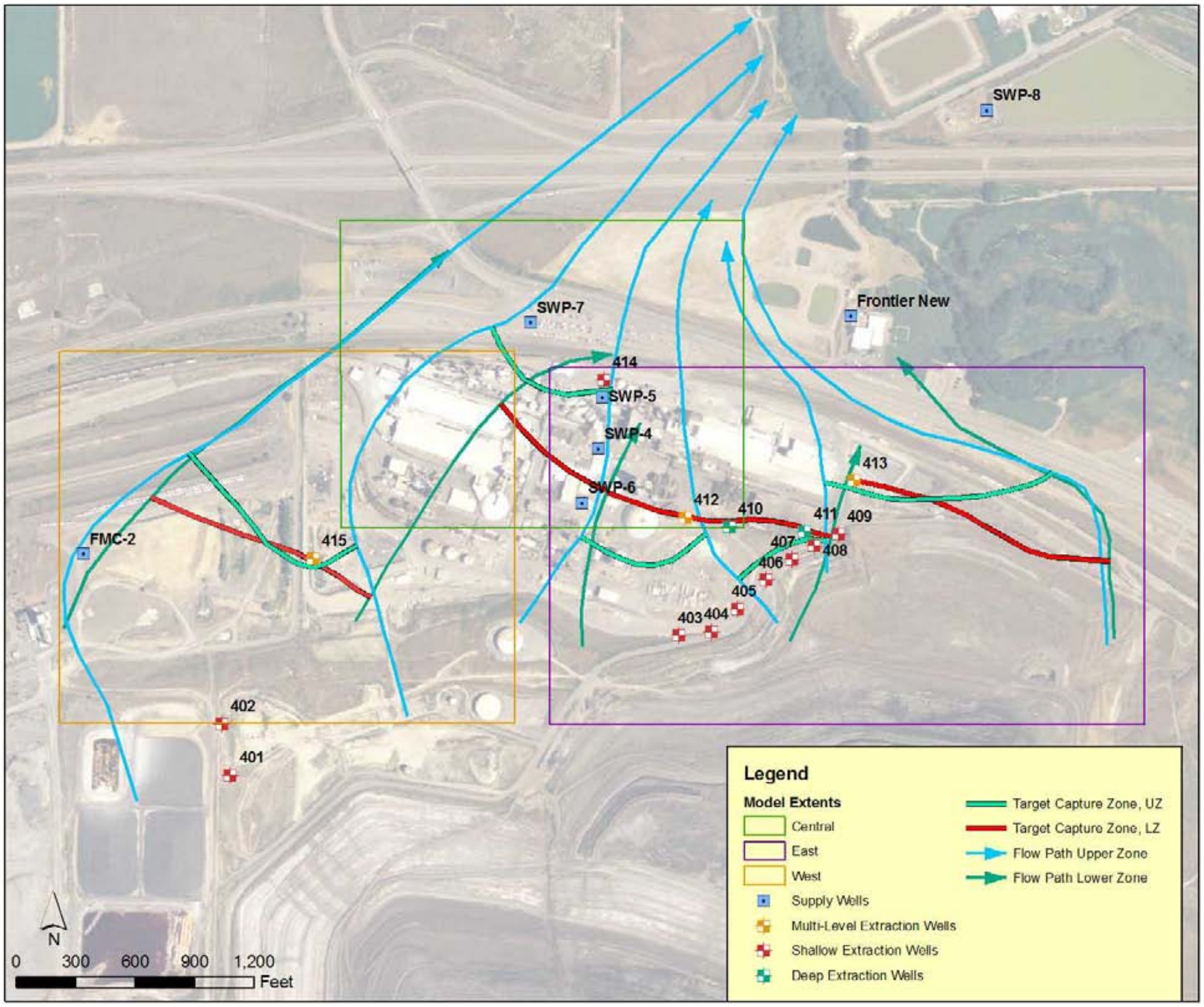

Figure A1: Approximate boundaries of model extents, East, Central and West.

3.1.2 Model Grid and Layers

A uniform grid is provided over the x-y plane at 25-foot spacing. The grid is 72 rows and 120 columns. Of the 60,480 total grid cells, 38,215 are active

The model area is divided vertically into seven layers as follows:

Layer 1: Upper Zone -, composed mostly of Michaud Gravel

Layer 2: American Falls Lake Bed Clay (AFLB) -, composed of sillt and clay

Layer 3: Upper portion of the Lower Zone - Silty and clayey, lower conductivity interval, composed of alluvial fan deposits in the south, and the Sunbeam Formation to the north

Layer 4: Middle portion of the Lower Zone - High conductivity interval, composed of alluvial fan gravel in the south, transitioning to clean quartzite sands and gravels of the Sunbeam Formation to the north

Layer 5: Lower portion of the Lower Zone - Silty and clayey, lower conductivity interval, composed of alluvial fan deposits in the south, and the Sunbeam Formation to the north.

Layer 6: Bedrock - primarily andesite of the Starlight Formation

Layer 7: Used for constant head boundary delineation at an elevation of 30 feet below the top of bedrock

Layer 1 is designated unconfined (Type 1) and layer 7 is designated confined (Type 0). All other layers are modeled as convertible between unconfined and confined with variable transmissivity (Type 3).

Layer top and bottom elevations were assigned by importing mapped hydrostratigraphic surfaces that were developed as part of the CSM for groundwater (NewFields 2008). At the southern extent of the model area all of the saturated alluvial units terminate at the Bannock Mountain front. To accommodate the layer continuity requirement in Modflow, layer 1 (Upper Zone), layer 2 (AFLB), and layer 3 (upper portion of Lower Zone). are draped over the top of bedrock at minimal thickness where they are non-existent. Most of cells in this area are dry in modeling simulations and can be converted to no-flow cells. Other cells in Layers 1 through 5 south of their extents were attributed with hydraulic properties consistent with the existing material based on location and elevation.

3.1.3 Model Boundaries

Constant head boundaries were used on the north and south edges of the model, and were placed along potentiometric lines using potentiometric maps of the Upper, Lower and Bedrock Zones. Constant head boundaries are as follows for each layer:

Layer 1: Constant head boundaries along north and south model extents are based on August 2003, steady-state potentiometric surface for the Upper Zone.

Layer 2: No constant head boundaries.

Layer 3: No constant head boundaries.

Layer 4: Constant head boundaries based on August 2003, steady-state potentiometric surface for the Lower Zone..

Layer 5: No north and south boundaries.

Layer 6: North. Constant head boundary based on 2008 Q2 potentiometric surface (first-available bedrock potentiometric surface).

Layer 7: All active cells. Constant head boundary based on 2008 Q2 potentiometric surface (first-available bedrock potentiometric surface).

.Flow lines interpreted from the August 2003 steady-state potentiometric surface were used to develop no-flow boundaries on the east and west sides of the model, based on the assumption that ground water flow into and out of the model is negligible perpendicular to local flow lines.

Recharge is applied to the highest active layer at a rate of 1 in/yr

3.1.4 Model Simulations

Two simulations were made to evaluate extraction well design. The first simulation represents non-pumping, steady-state conditions. This simulation was developed first, and was used to evaluate the performance of the model with respect to assumptions for aquifer parameters and boundary conditions. Parameters were adjusted within the range of observed values to obtain a reasonable match between simulated and observed head values and groundwater flow. In the second simulation, the existing pumping wells were added and boundary conditions adjusted to represent observed pumping water levels. Using this pumping simulation, particle tracking was conducted to evaluate the effectiveness of the existing pumping wells and evaluate positions and pumping rates for additional extraction wells.

3.1.4.1 Comparison of Steady-State Simulation to Observations and Other Calculations

The steady state simulation was compared to the non-pumping, steady-state water levels from August, 2003. A series of model runs were made by varying boundary conditions and aquifer parameters to achieve a reasonable fit to the observed ground water flow conditions. A series of hydraulic conductivity zones were used within each model layer to provide a spatial variation that both fits the groundwater CSM and falls within the range estimated from the results aquifer testing.. A summary of the hydraulic conductivity zones and values used in the best fit case are povided in Tables A1 and A2.

Figures A2 through A5 show the modeled potentiometric surface for steady-state conditions (August 2003). Figure A6 shows the head contours in cross-section, from south to north near well 412. These figures show northward and upward flow directions, as observed at the site.

Table A1: Description of hydrogeologic characteristics of zones used in East model.

Zone	Layer	Description
1	1	Lower conductivity zone of Michaud Gravel, Upper Zone
	2	Lower conductivity zone of Michaud Gravel, Upper Zone, south of AFLB southern extent
	3	Lower conductivity zone of alluvial fan gravel, Lower Zone
	4	Lower conductivity zone of alluvial fan gravel, Lower Zone
	5	Lower conductivity zone of alluvial fan gravel, Lower Zone
2	1	Higher conductivity zone of Michaud Gravel, Upper Zone
	4	Higher conductivity zone of Michaud Gravel, Upper Zone
3	1	Highest conductivity zone of Michaud Gravel, Upper Zone
4	2	Clay layer, AFLB
5	2	Silty and clayey intervals of alluvial fan gravels and Sunbeam Formation, Lower Zone, northeast of AFLB extent
6	3	Silty and clayey intervals of alluvial fan gravels and Sunbeam Formation, Lower Zone
	5	Silty and clayey intervals of alluvial fan gravels and Sunbeam Formation, Lower Zone
7	4	Higher conductivity interval of alluvial fan gravels and Sunbeam Formation, Lower Zone
10	7	Bedrock conductivity, 30 feet below top of bedrock, Starlight Formation
11	6	Bedrock conductivity, 0 to 30 feet below top of bedrock, showing enhanced vertical conductivity

Table A2: Zone codes and associated hydraulic conductivity values used in the East model.

Zone	K_x (ft/day)	K_y (ft/day)	K_z (ft/day)
1	25	25	2.5
2	200	200	20
3	700	700	70
4	0.01	0.01	0.001
5	60	60	6
6	60	60	6
7	162	162	16
8	524	524	52
10	1	1	0.1
11	1	1	1

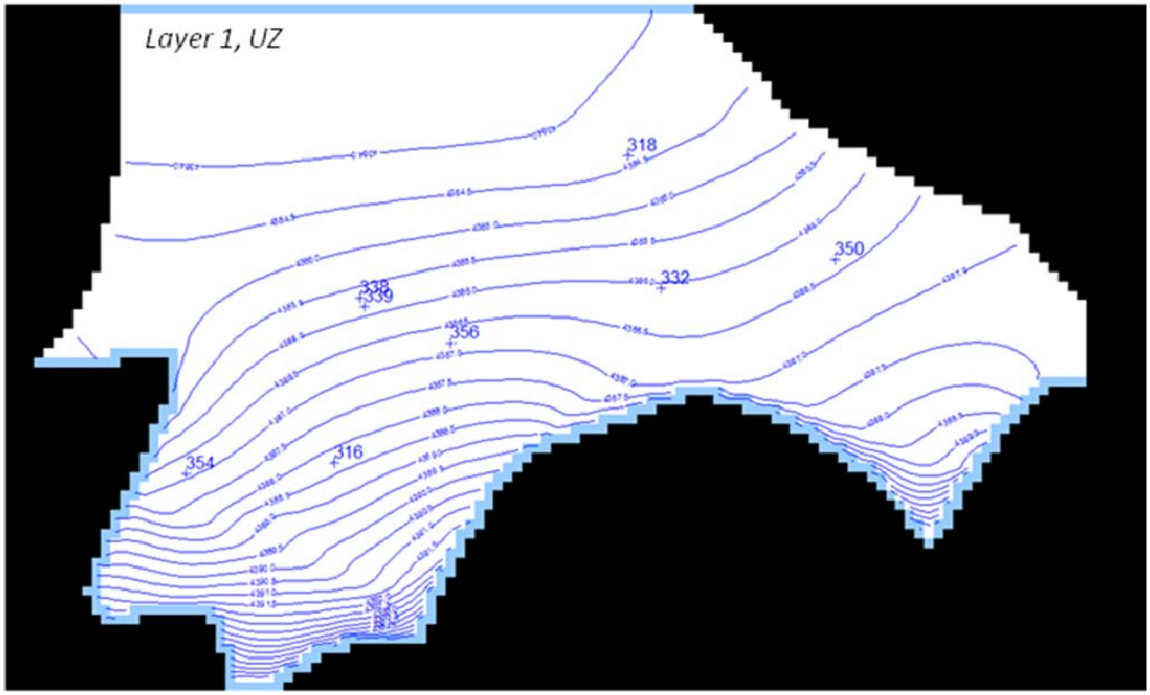

Figure A2: **Modeled potentiometric surface for the upper zone (Layer 1) at steady-state conditions (8/2003). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Monitoring wells are shown and labeled.**

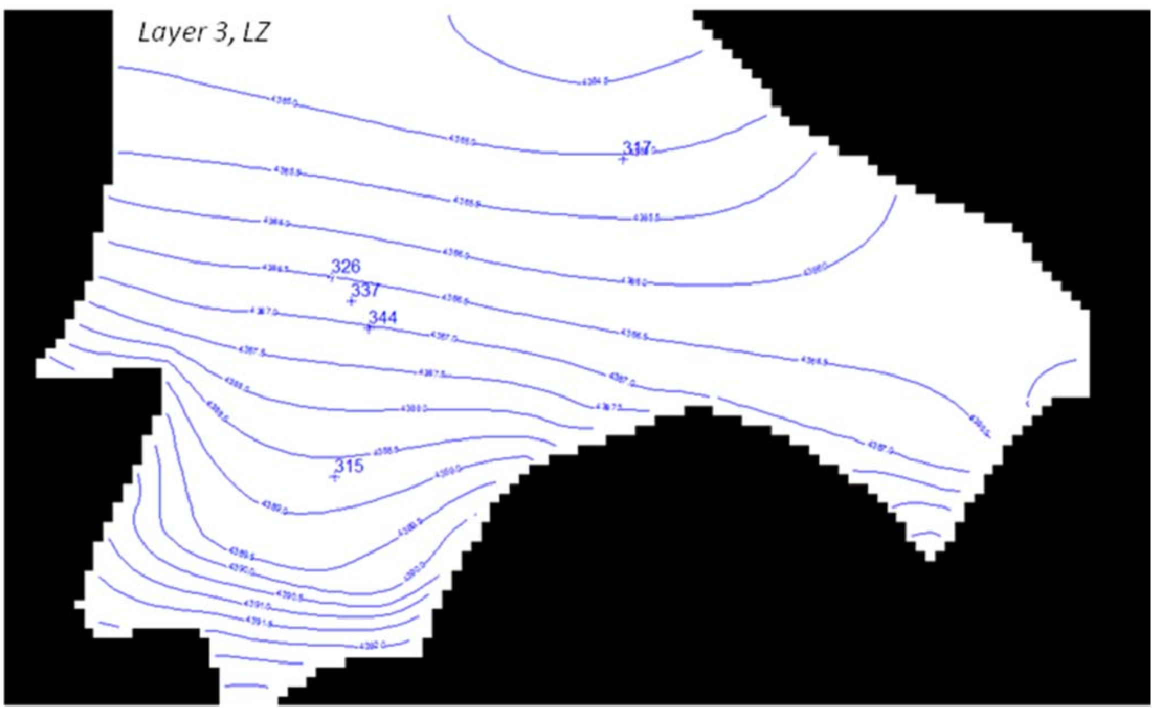

Figure A3: **Modeled potentiometric surface for the first interval of the lower zone (Layer 3) at steady-state conditions (8/2003). Light blue areas represent constant head**

boundaries. Black areas are zones of no flow. Monitoring wells are shown and labeled.

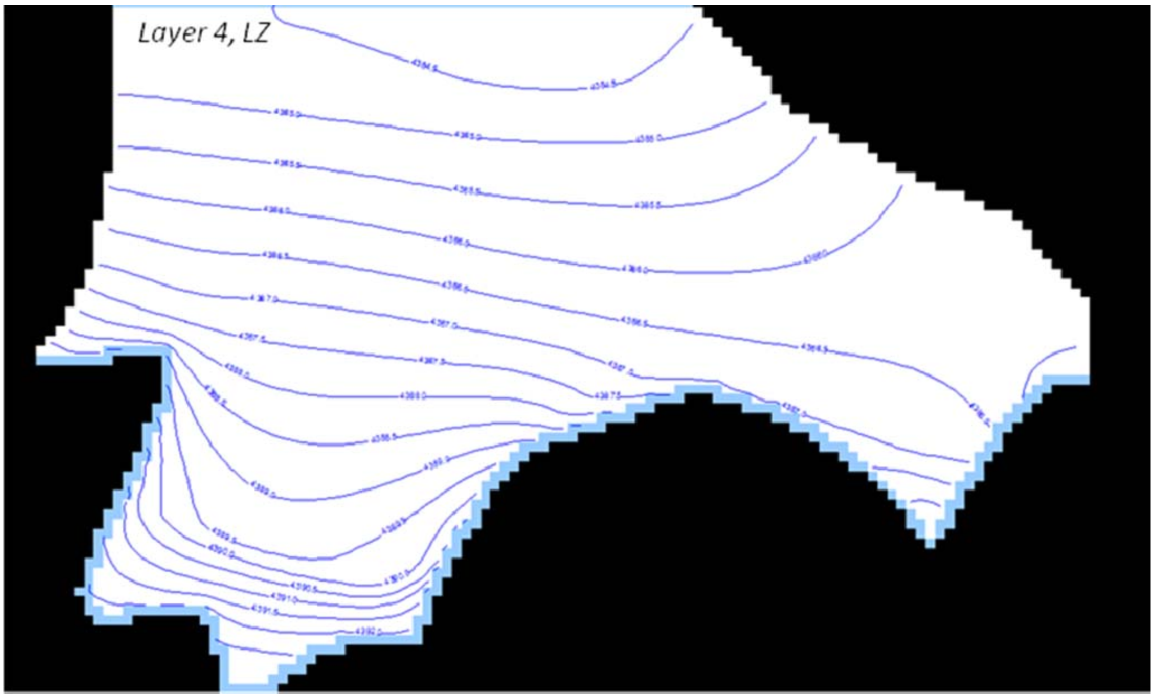

Figure A4: Modeled potentiometric surface for the second interval of the lower zone (Layer 4) at steady-state conditions (8/2003). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Monitoring wells are shown and labeled.

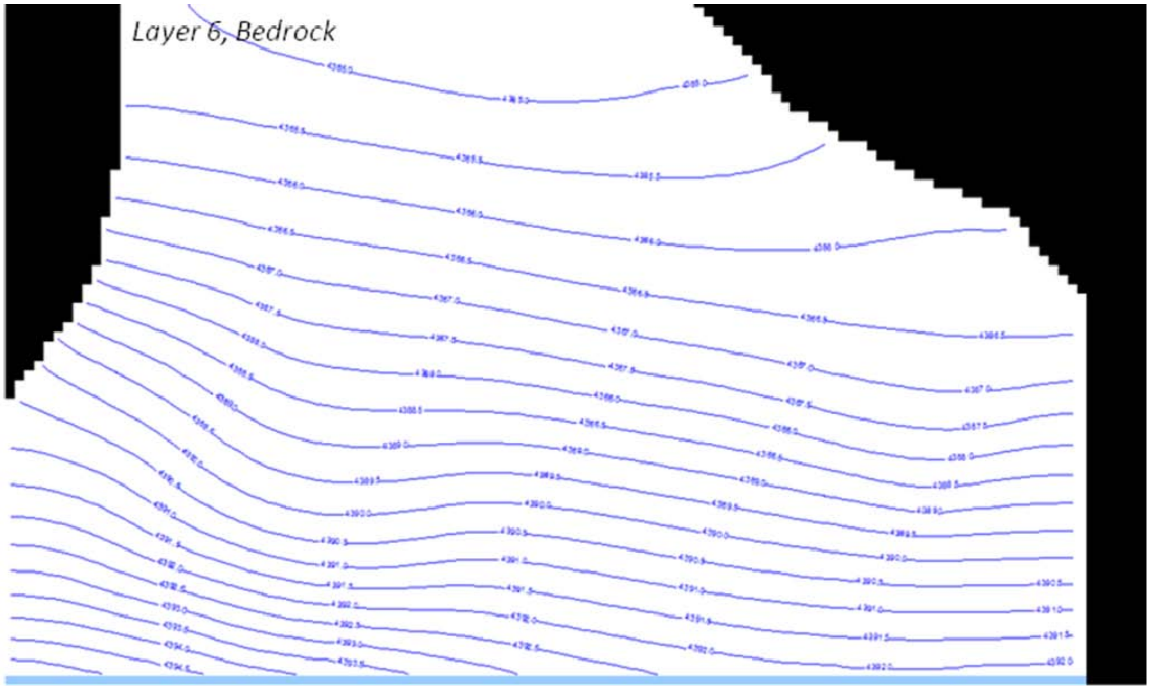

Figure A5: Modeled potentiometric surface for bedrock (Layer 6) at steady-state conditions (8/2003). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Monitoring wells are shown and labeled.

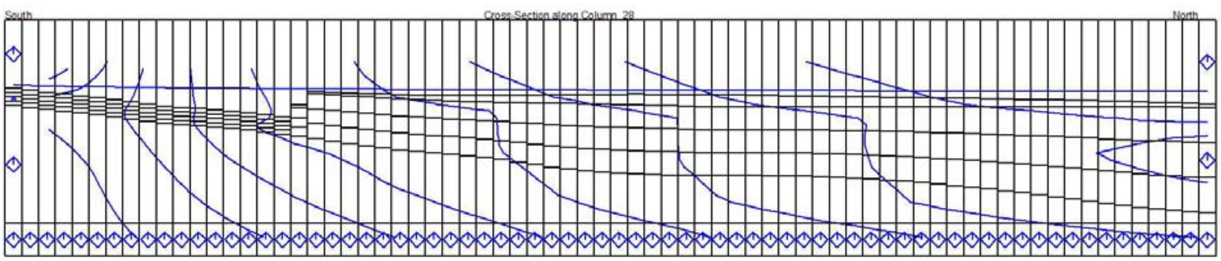

Figure A6: Steady-state head contours are shown in cross-section from south to north near well 412.

3.1.4.2 Simulation of Pumping Conditions

For the pumping simulations, the steady-state non-pumping flow simulation was modified by adjusting the boundary conditions and adding pumping wells 404 – 413. Constant head boundaries for Layers 1 and 4 were modified to better simulate the potentiometric surface mapped based on the 2008 Q2 water levels, but the geometry remained the same. The zoning used in the non-pumping simulation was retained in the pumping simulation. Initial heads were imported from the results of the non-pumping simulation..

Eleven pumping wells were added to the pumping model. Pumping rates were determined from recorded pumping rates documented in the Groundwater Extraction System Report for July 2008 (NewFields 2008a). For multi-level extraction wells (412 and 413), flow rates were distributed across screened interval based on tracer pulse survey tests conducted as part of the Phase 2 Data Gap Investigation (NewFields 2008b). A summary of the simulated pumping rates is included in Table A3.

Table A3: Pumping rates for extraction wells included in the East model.

Pumping Well	X	Y	Elevation of Top of Screen (ft amsl)	Elevation of Bottom of Screen (ft amsl)	Q (gpm)
404	560,604.29	451,883.37	4,399.44	4,379.44	1.5
405	560,736.37	451,998.69	4,401.00	4,381.00	1.7
406	560,878.14	452,144.64	4,394.80	4,374.80	9.9
407	561,010.29	452,245.87	4,395.98	4,375.98	3.9
408	561,120.70	452,318.57	4,389.90	4,369.90	0.4
409	561,244.26	452,375.92	4,394.10	4,374.10	3.6
410	560,696.30	452,413.30	4,334.00	4,294.00	97.5
411	561,072.90	452,387.90	4,341.00	4,301.00	59.3
412A	560,464.89	452,451.47	4,394.75	4,382.65	50
412E	560,464.89	452,451.47	4,282.65	4,272.65	339
413A	561,325.54	452,642.78	4,391.15	4,381.15	25
413C	561,325.54	452,642.78	4,328.15	4,310.15	100

Aquifer parameters were adjusted in the pumping simulation to allow a better fit to some of the observed water level data from pumping tests. The adjusted aquifer properties for the pumping simulation are shown in Table A4.

Table A4: Zone codes and associated hydraulic conductivity values used in the pumping simulation.

Zone	K_x (ft/day)	K_y (ft/day)	K_z (ft/day)
1	100	100	10
2	500	500	50
3	1000	1000	100
4	0.01	0.01	0.001
5	50	50	5
6	50	50	5
7	150	150	15
10	1	1	0.1
11	1	1	1

In addition to simulating all pumping wells, major pumping wells were also simulated individually, and the simulated drawdown cones compared to observed data from pumping tests conducted in 2008. The maximum sustainable pumping rates were determined during pumping tests (NewFields 2008b). The hydraulic conductivity of a unit affects the shape of the cone of depression around a pumping well. Individual pumping wells were simulated modeled using observed drawdown values from pumping tests to confirm that aquifer properties and boundary conditions used were adequate over the entire model. Pumping wells simulated individually are shown in Table A5.

Table A5: Pumping rates for extraction wells modeled individually in the East area.

Pumping Well	X	Y	Elevation of Top of Screen (ft amsl)	Elevation of Bottom of Screen (ft amsl)	Q (gpm)
410	560,696.30	452,413.30	4,334.00	4,294.00	140
411	561,072.90	452,387.90	4,341.00	4,301.00	80
412A	560,464.89	452,451.47	4,394.75	4,382.65	36
412B			4,347.65	4,343.65	64
412C			4,330.65	4,317.65	186
412D/E			4,310.65	4,272.65	204
413A	561,325.54	452,642.78	4,391.15	4,339.15	145
413C			4,328.15	4,310.15	20

Figures A7 and A8 show the modeled potentiometric surface for current pumping conditions (2008). Figures A9 and A10 show the head contours in cross-section, from south to north near well 412 and 413, respectively.

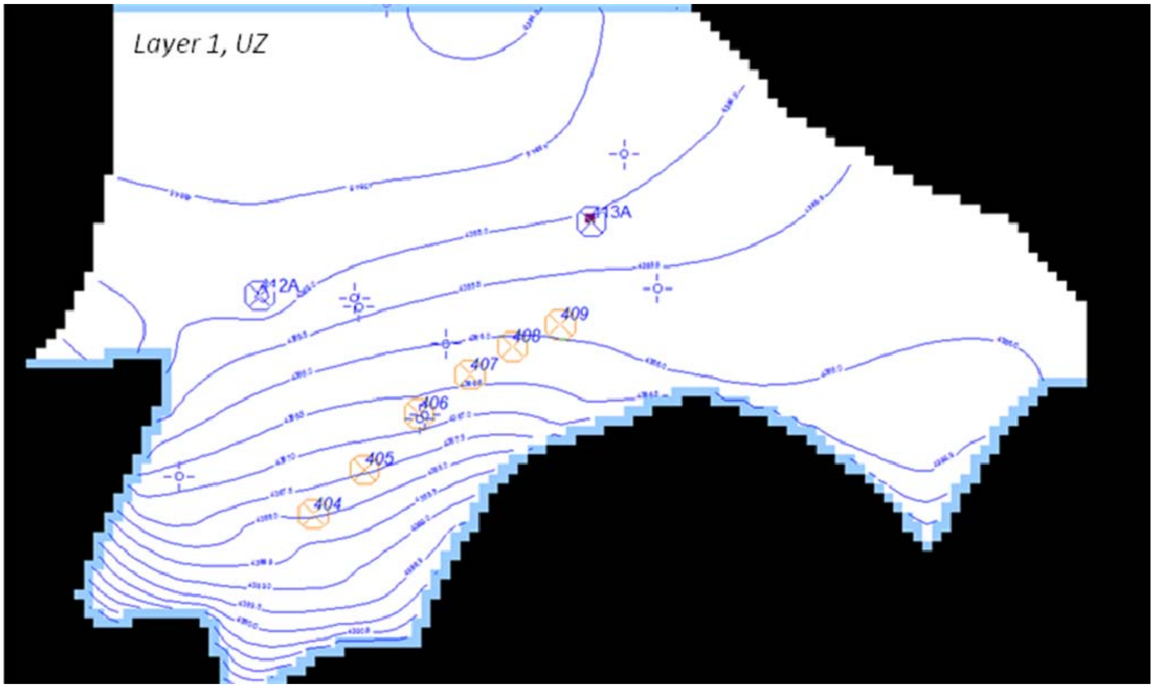

Figure A7: Modeled potentiometric surface for the upper zone (Layer 1) at current pumping conditions (2008). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Pumping well are shown and labeled. Monitoring wells are shown as crosses.

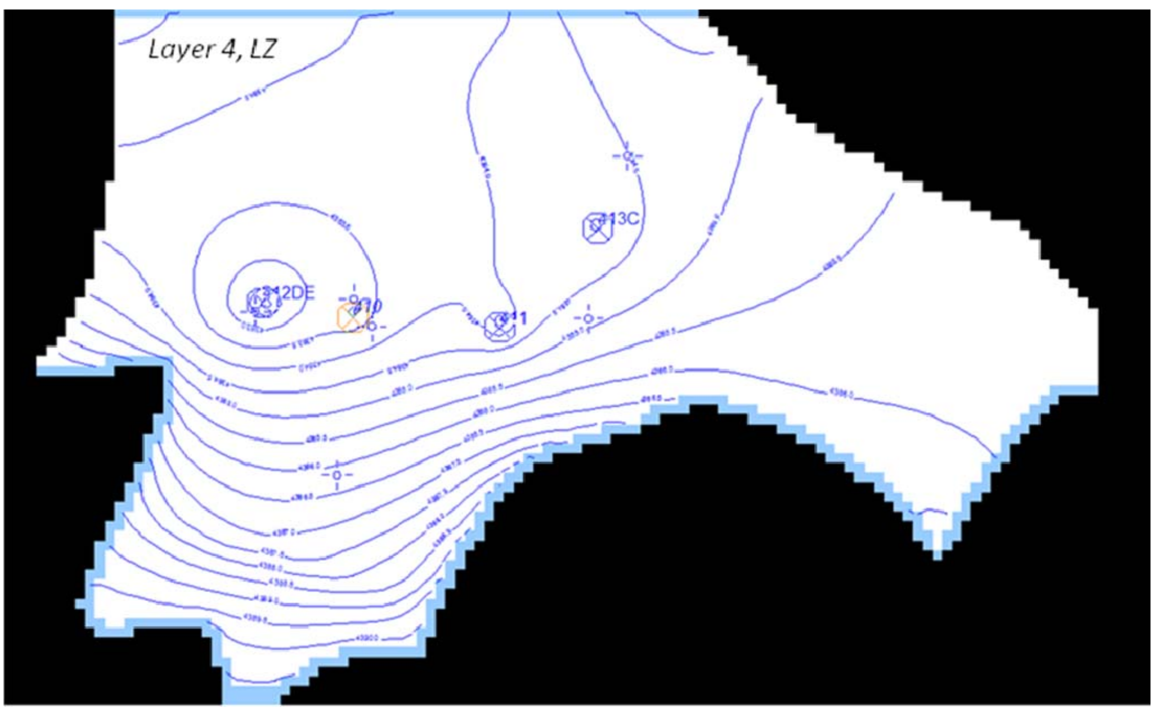

Figure A8: Modeled potentiometric surface for the lower zone (Layer 4) at current pumping conditions (2008). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Pumping well are shown and labeled. Monitoring wells are shown as crosses.

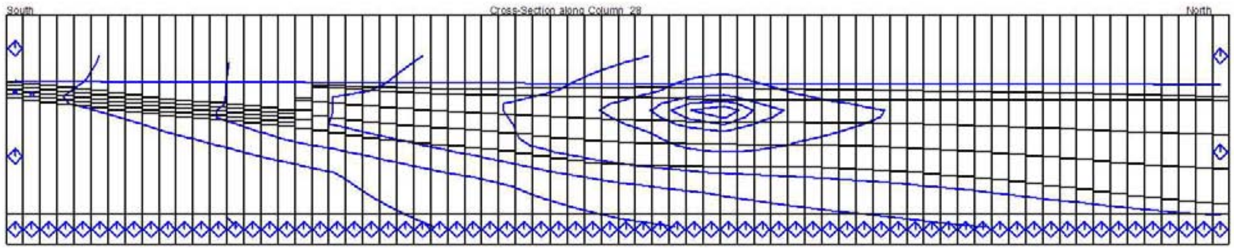

Figure A9: Head contours from the 2008 pumping condition are shown in cross-section from south to north near well 412.

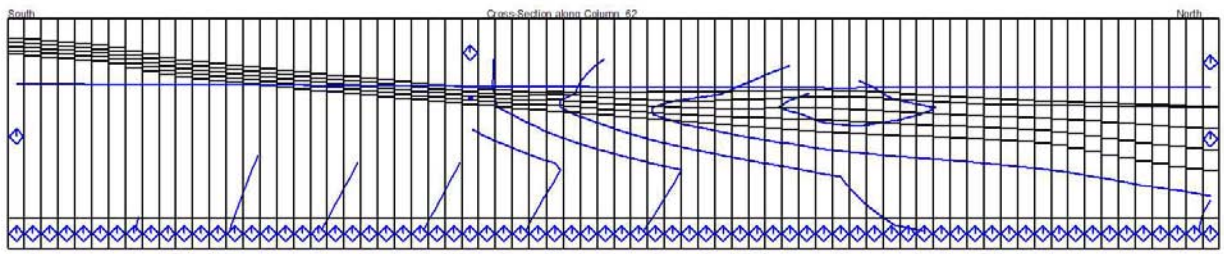

Figure A10: Head contours from the 2008 pumping condition are shown in cross-section from south to north near well 413.

3.2 Central Model

3.2.1 Selection of Model Area

The Central model area was selected based on the target capture zone and the August 2003 steady-state potentiometric surface for both the Upper and Lower Zones. in the Phosphoric Acid Plant area. The Central model only considers the Central target capture zone for the Upper Aone. The model extends from the approximately the gypsum stack in the south to Highway 86 in the north. At the southern extent of the model, elevated bedrock causes the termination of the saturated portions of overlying sedimentary layers (i.e. the Upper and Lower Zones terminate, and only the Bedrock Zone is saturated). The Central model area is shown in Figure A1.

3.2.2 Model Grid and Layers

A grid is provided over the x-y plane at spacing ranging from 5 to 40 feet. Smaller grid cells were employed near potential groundwater extraction locations, and larger cells are used toward the edges of the active cell area. The grid is 109 rows and 155 columns. Of the 50,685 total grid cells, 44,988 are active.

The model area is divided vertically into three layers as follows:

Layer 1: Upper Zone, composed mostly of Michaud Gravel

Layer 2: AFLB Clay , composed of silt and clay

Layer 3: Lower Zone, composed of alluvial fan gravel in the south, grading to clean quartzite sands and gravels of the Sunbeam Formation to the north

Layer 1 is designated unconfined (Type 1). Layers 2 and 3 are modeled as convertible between unconfined and confined with variable transmissivity (Type 3). Layer top and bottom elevations were assigned by importing mapped hydrostratigraphic surfaces that were developed as part of the CSM for groundwater (NewFields 2008).

3.2.3 Model Boundaries

Constant head boundaries were used on the north and south edges of the model, and were placed approximately along potentiometric lines in the Upper and Lower Zones. North and south boundaries are as follows for each layer:

Layer 1: Constant head boundaries along the north and south boundaries are based on the steady-state, August 2003 potentiometric surface for the Upper Zone.

Layer 2: No constant head boundaries.

Layer 3: Constant head boundaries based on the steady-state, August 2003 potentiometric surface for the Lower Zone.

Flow lines interpreted from the steady-state potentiometric surface from August 2003 were used to develop no-flow boundaries on the east and west sides of the model, based on the assumption that ground water flow in to and out of the model is negligible perpendicular to local flow lines.

Recharge is applied to the highest active layer at a rate of 1-2 in/yr.

3.2.4 Model Simulations

Two simulations were made to evaluate extraction well design. The first simulation represents non-pumping, steady-state conditions. This simulation was used to evaluate the performance of the model with respect to the assumptions for aquifer parameters and boundary condition . Parameters were adjusted within the range of observed values to obtain a reasonable match between simulated and observed head values and groundwater flow. In the second simulation, the existing pumping well was added and boundary conditions adjusted to represent observed pumping water levels. Using this pumping simulation, particle tracking was conducted to evaluate the effectiveness of the existing pumping well and evaluate positions and pumping rates for additional extraction wells.

3.2.4.1 Comparison of Steady-State Simulation to Observations and Other Calculations

The steady state simulationl was compated to the non-pumping water levels from August 2003. A series of model runs were made by with varying boundary conditions and aquifer parameters to achieve a reasonable fit to the observed ground water flow conditions. A series of hydraulic conductivity zones were used within each model layer to provide a spatial variation that both fits the groundwater CSM and falls within the range estimated from the results aquifer testing.. A summary of the hydraulic conductivity zones and values used in the best fit case are povided in Tables A6 and A7.

Figures A11 and A12 show the modeled potentiometric surface for current conditions (August 2003). Figure A13 shows the head contours in cross-section, from south to north near well 414. These figures show north/northeast and upward flow directions, as observed at the site.

Table A6: Description of hydrogeologic characteristics of zones used in the Central model.

Zone	Layer	Description
1	1	Michaud Gravel, Upper Zone
2	2	American Falls Lake Bed clay
3	3	Alluvial fan gravels and Sunbeam Formation, Lower Zone

Table A7: Zone codes and associated hydraulic conductivity values used n the Central model.

Zone	K_x (ft/day)	K_y (ft/day)	K_z (ft/day)
1	800	800	80
2	0.001	0.001	0.0001
3	100	100	10

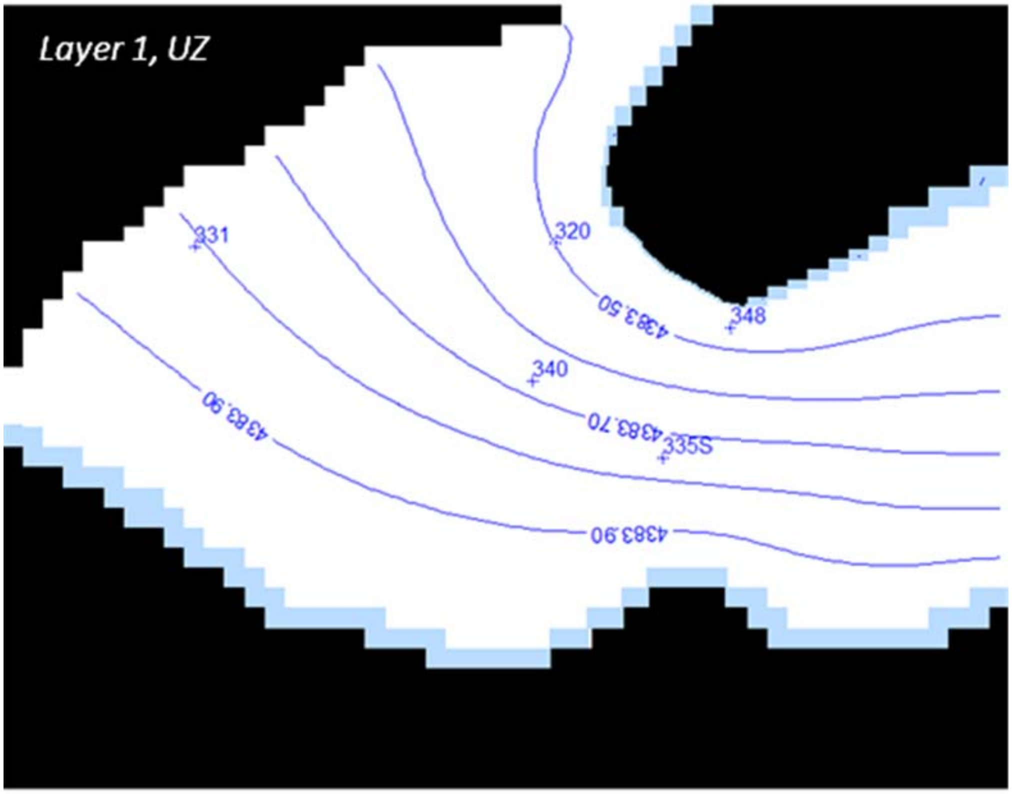

Figure A11: Modeled potentiometric surface for the upper zone (Layer 1) at steady-state conditions (8/2003). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Monitoring wells are shown and labeled.

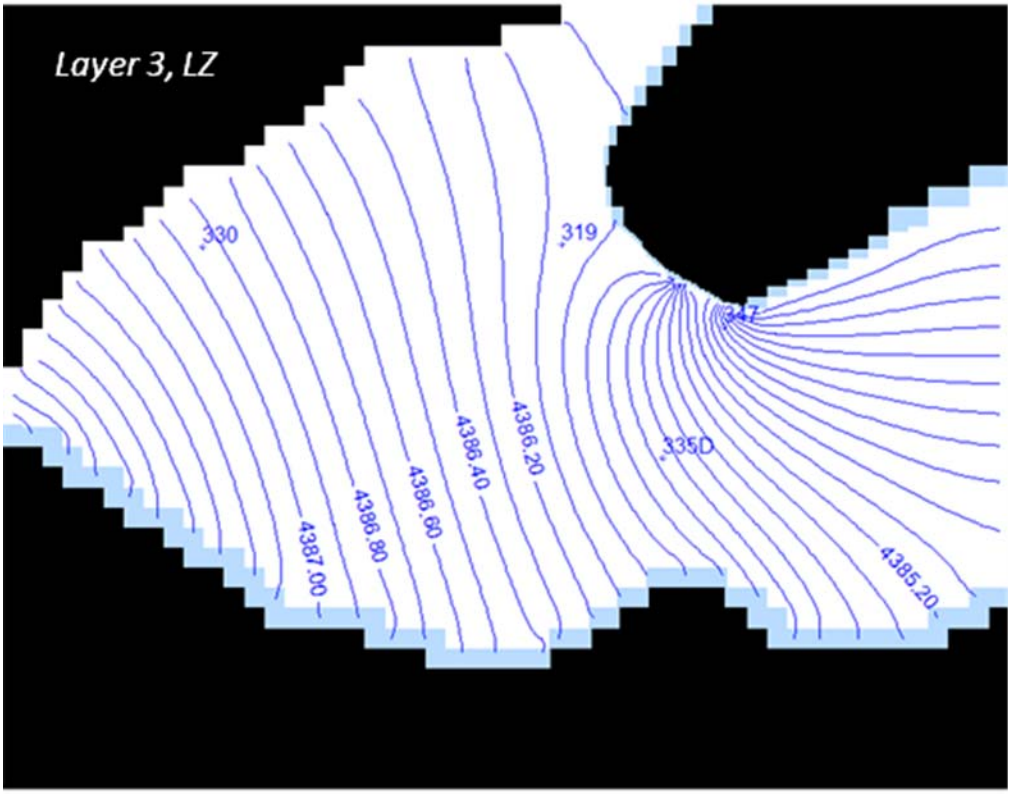

Figure A12: Modeled potentiometric surface for the lower zone (Layer 3) at steady-state conditions (8/2003). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Monitoring wells are shown and labeled.

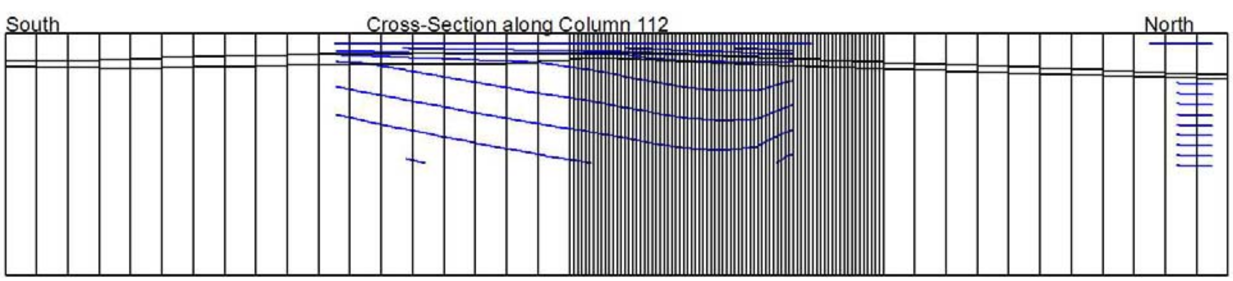

Figure A13: Cross-section of central area showing head contours from south to north near well 414.

3.2.4.2 Simulation of Pumping Conditions

For the pumping simulation, the steady-state non-pumping flow model was modified by adjusting the boundary conditions and adding pumping well 414. Constant head boundaries for Layer 1 were modified to better simulate the potentiometric surface mapped based on the water levels from January 2009, and the geometry was edited slightly based on the new potentiometric surface and flow lines. The zoning used in the non-pumping simulation was retained in the pumping simulation. Hydraulic conductivity values in the upper zone (layer 1) were increased to (K_x, K_y, K_z) = (2600, 2600, 260) ft/day based on updated hydrogeologic data from the Phosphoric Acid Plant area (Simplot 2009). Initial heads for the pumping simulation were imported from the results of the non-pumping simulation . Figure A14 shows the 2009 modeled potentiometric surface under non-pumping conditions.

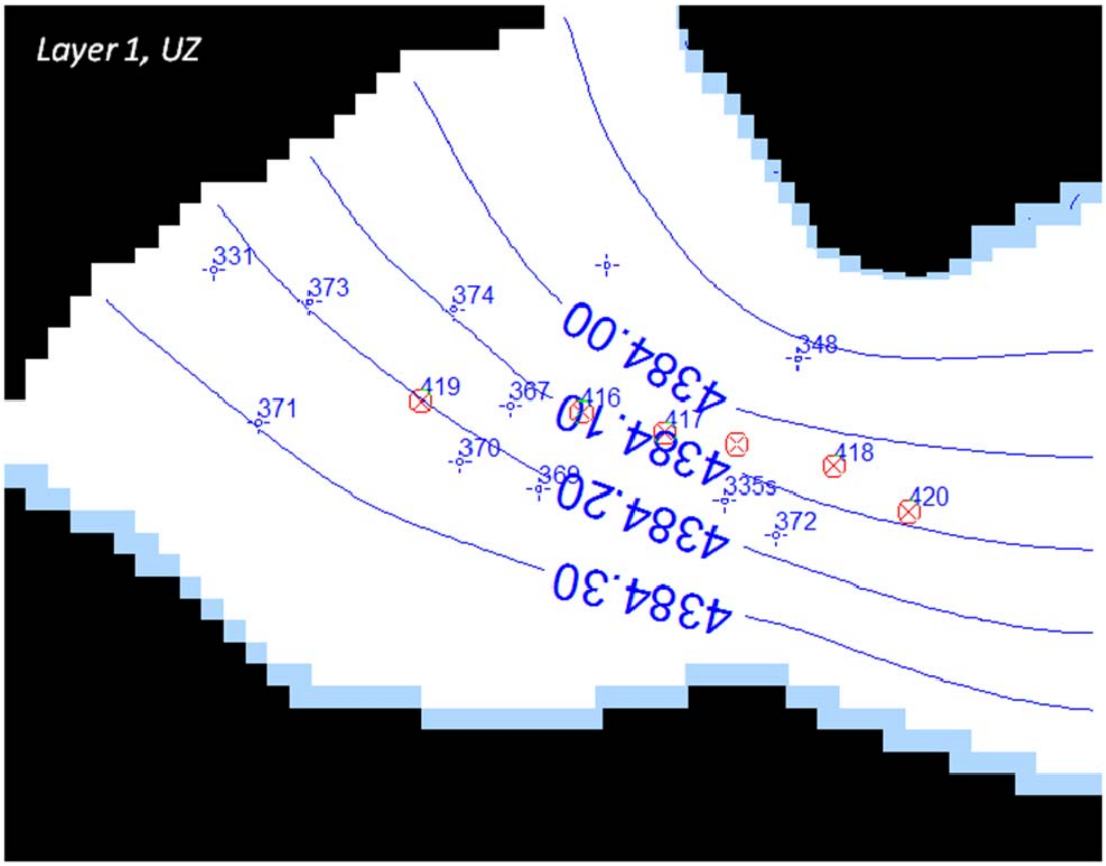

Figure A14: **Modeled p otentiometric surface for the uppe r zon e (L ayer 1) at cu rrent conditions (2009). Light blue areas represent constant head boundaries. Black areas are zones of n o fl ow. Pumpin g well ar e s hown an d labeled. Monitoring wells are shown as crosses.**

The pumping rates for wells 414, 416, and 419 were estimated from pumping tests performed 2008 and 2009 (NewFields 2008b). A summary of simulated pumping rates for these wells is included in Table A8. Figure A15 shows the modeled potentiometric surface for current conditions (2009), and Figure A16 shows a cross-section of pumping conditions near well 414.

Table A8: Pumping rate for extraction wells 414, 416, and 419.

Pumping Well	X	Y	Elevation of Top of Screen (ft amsl)	Elevation of Bottom of Screen (ft amsl)	Q (gpm)
414	560,062.7	453,154.0	4,383.44	4,373.44	25
416	559,782.3	453,227.0	4388.04	4373.04	35
419	599,490.3	453,246.1	4385.7	4360.7	35

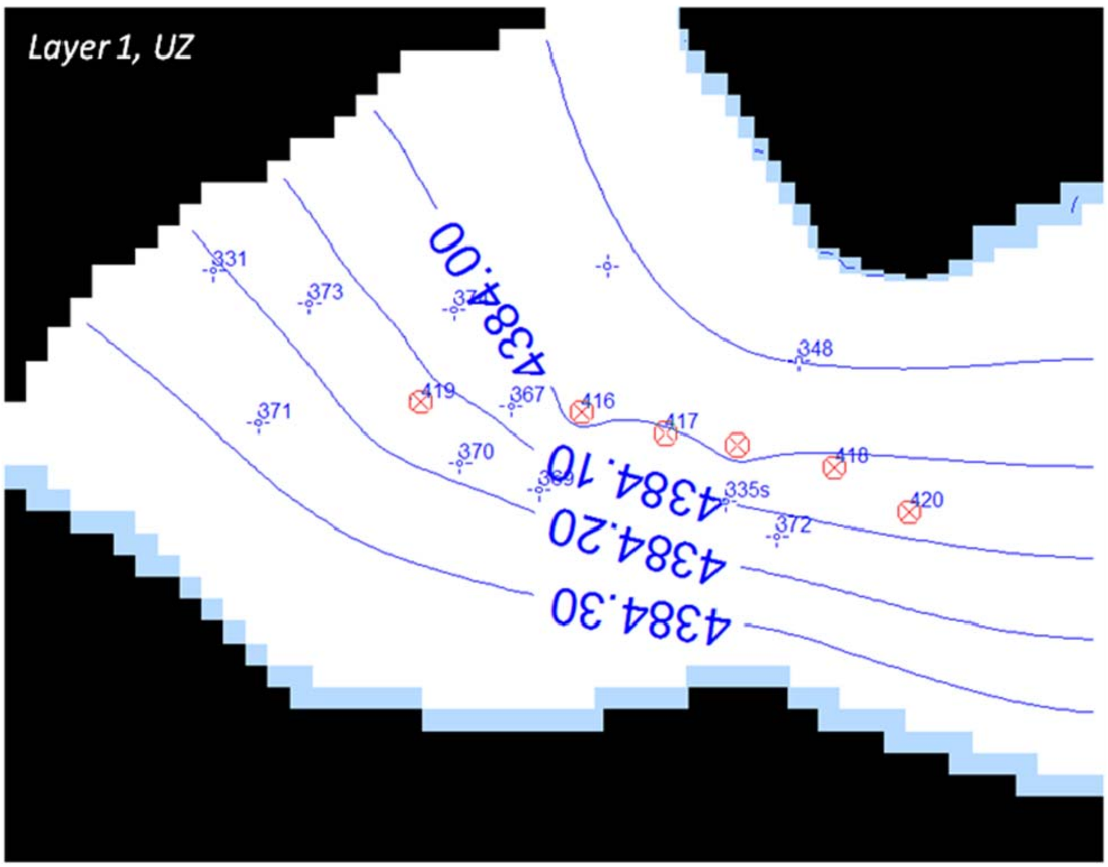

Figure A15: Modeled potentiometric surface for the upper zone (Layer 1) at current pumping conditions (2009). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Pumping well are shown and labeled. Monitoring wells are shown as crosses.

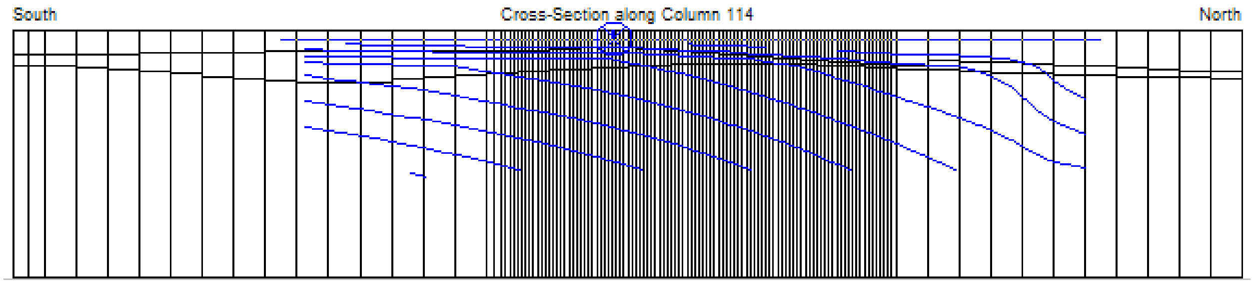

Figure A16: Head contours from the 2009 pumping condition are shown in cross-section from south to north near well 414. Since 414 is screened in the upper zone, the effect of pumping is difficult to see in cross-section at this scale.

3.3 West Model

3.3.1 Selection of Model Area

The West model area was selected based on target capture zones and the August 2003 steady-state potentiometric surface for both the Upper and Lower Zones. The West model includes the Upper and Lower Zone West (or "Fenceline") target capture zones. The model extends from approximately 350 feet north of the gypsum stack to Highway 86 in the north to maintain boundaries beyond expected zone of influence for the pumping wells. The AFLB clay unit is not present in the southern portion of the modeled area, The West model area is shown in Figure A1.

3.3.2 Model Grid and Layers

A uniform grid is provided over the x-y plane at 25-foot spacing. The grid is 75 rows and 92 columns. Of the 34,500 total grid cells, 21,030 are active.

The modeled area is divided vertically into five layers as follows:

Layer 1: Upper Zone - composed mostly of Michaud Gravel

Layer 2: AFLB Clay - composed of silt and clay

Layer 3: Lower Zone - , composed of alluvial fan gravel in the south, grading to clean quartzite sands and gravels of the Sunbeam Formation to the north.

Layer 4: Bedrock - primarily andesite of the Starlight Formation

Layer 5: Used for constant head boundary delineation at an elevation of 30 feet below the top of bedrock

Layer 1 is designated unconfined (Type 1) and layer 5 is designated confined (Type 0). All other layers are modeled as convertible between unconfined and confined with variable transmissivity (Type 3). Constant head boundaries were placed in Layers 1 and 3 at the northern and southern extents, in Layer 4 at the southern extent, and in all active cells of Layer 5.

Layer top and bottom elevations were assigned by importing mapped hydrostratigraphic surfaces that were developed as part of the CSM for groundwater (NewFields 2008).. At the southern extent of the model area, the American Falls Lake Bed (AFLB) pinches out. To accommodate the layer continuity requirement in Modflow, the top and bottom elevation of the AFLB was modeled at a constant interval above the top of bedrock where it is non-existent. Some cells in this area are dry in modeling simulations and can be converted to no-flow cells. Areas of elevated bedrock on the south edge and central portion of the model caused some cells to go dry during modeling. Along the south edge, some of these cells were converted to no-flow cells. In other areas, cells remain dry as modeled. Saturated cells in Layers 1 through 3 located south of the AFLB extent were attributed with hydraulic properties consistent with the existing material based on location and elevation.

3.3.3 Model Boundaries

Constant head boundaries were used on the north and south edges of the model, and were placed along potentiometric lines using potentiometric maps of the Upper, Lower and Bedrock Zones. Constant head boundaries are as follows for each layer:

> Layer 1: Constant head boundaries are based on August 2003, steady-state potentiometric surface for the Upper Zone.
>
> Layer 2: No constant head boundaries.
>
> Layer 3: Constant head boundaries are based on August 2003, steady-state potentiometric surface for the Lower Zone.
>
> Layer 4: No constant head boundaries.
>
> Layer 5: All active cells. Constant head boundary based on 2008 Q2 potentiometric surface (first-available bedrock potentiometric surface).

Flow lines interpreted from the August 2003 steady-state potentiometric surface were used to develop no-flow boundaries on the east and west sides of the model, based on the assumption that ground water flow into and out of the model is negligible perpendicular to local flow lines.

Recharge is applied to the top layer only (Layer 1) at a rate of 1 in/yr.

3.3.4 Model Simulations

Two simulations were made to evaluate extraction well design. The first simulation represents non-pumping, steady-state conditions. This simulation was developed first, and was used to evaluate the performance of the model with respect to assumptions for aquifer parameters and boundary conditions. Parameters were adjusted within the range of observed values to obtain a reasonable match between simulated and observed head values and groundwater flow. In the second model, the existing pumping well (well 415) was added and boundary conditions adjusted to represent observed pumping water levels. Using this pumping simulation, particle tracking was conducted to evaluate the effectiveness of the existing pumping well. .

3.3.4.1 Comparison of Steady-State Simulation to Observations and Other Calculations

The steady state simulation was sompared to the non-pumping, steady-state water levels from August, 2003. A series of model runs were made by varying boundary conditions and aquifer parameters in order to achieve a reasonable fit to the observed ground water flow conditions. A series of hydraulic conductivity zones were used within each model layer to provide a spatial variation that both fits the groundwater CSM and falls within the range estimated from the results aquifer testing.. For areas south of where the AFLB pinches out, appropriate zones were used represent the absence of this clay layer . A summary of the hydraulic conductivity zones and values used in the best fit case are provided inTables A9 and A10.

Table A9: Description of hydrogeologic characteristics of zone codes used in the West model.

Zone	Layer	Description
1	1	Lower conductivity zone of Michaud Gravel and alluvial fan gravels, Upper and Lower Zones(south of AFLB extent)
	2	Lower conductivity zone of Michaud Gravel and alluvial fan gravels, Upper and Lower Zones (south of AFLB extent)
2	1	Higher conductivity zone of Michaud Gravel, Upper Zone
3	1	Highest conductivity zone of Michaud Gravel, Upper Zone
4	2	Clay layer, AFLB
6	3	Higher conductivity zone of alluvial fan gravels and Sunbeam Formation, Lower Zone
7	4	Lower conductivity zone of alluvial fan gravels and Sunbeam Formation, Lower Zone
8	4	Bedrock conductivity, Starlight Formation
	5	Bedrock conductivity, Starlight Formation

Table A10: Zone codes used in the West model with associated hydraulic conductivity values for the x, y and z directions.

Zone	K_x (ft/day)	K_y (ft/day)	K_z (ft/day)
1	197	197	19.7
2	250	250	25
3	501	501	50
4	0.01	0.01	0.001
6	75	75	7.5
7	75	75	7.5
8	1	1	0.1

Figures A17 through A19 show the modeled potentiometric surface for steady-state conditions (August 2003). Figure A20 shows the head contours in cross-section, from south to north near well 415. These figures show northward and upward flow directions, as observed at the site.

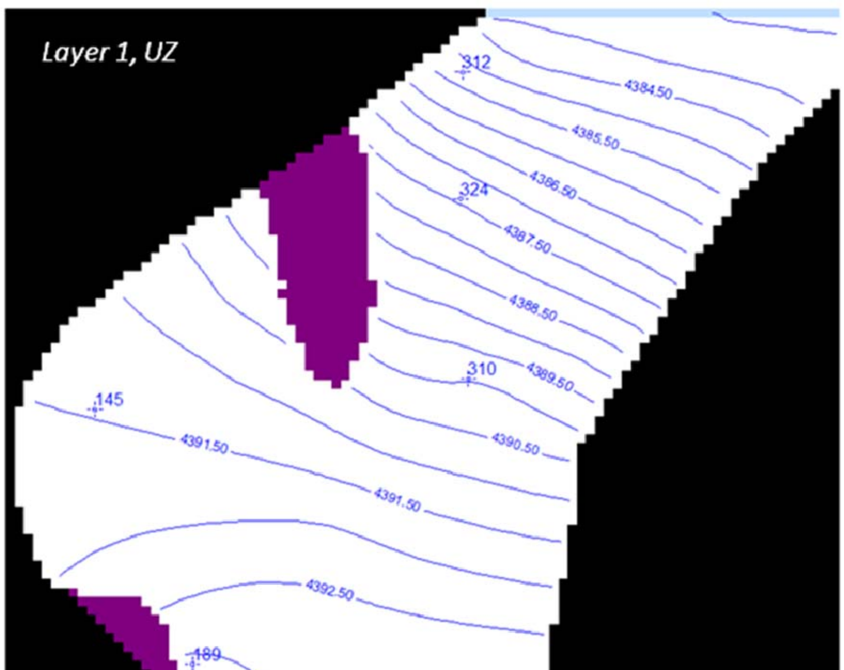

Figure A17: Modeled potentiometric surface for the upper zone (Layer 1) at steady-state conditions (8/2003). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Monitoring wells are shown and labeled.

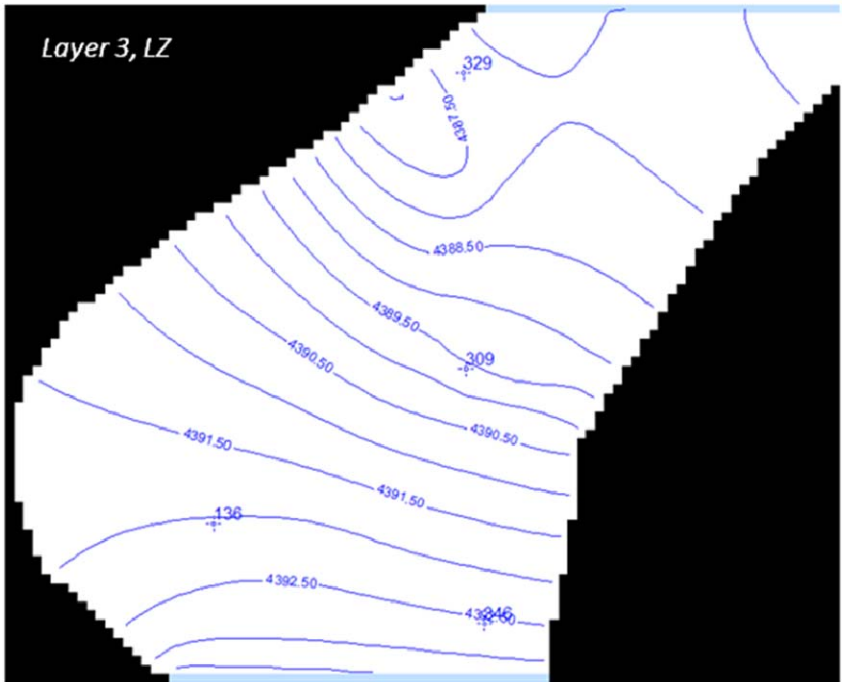

Figure A18: Modeled potentiometric surface for the lower zone (Layer 3) at steady-state conditions (8/2003). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Monitoring wells are shown and labeled.

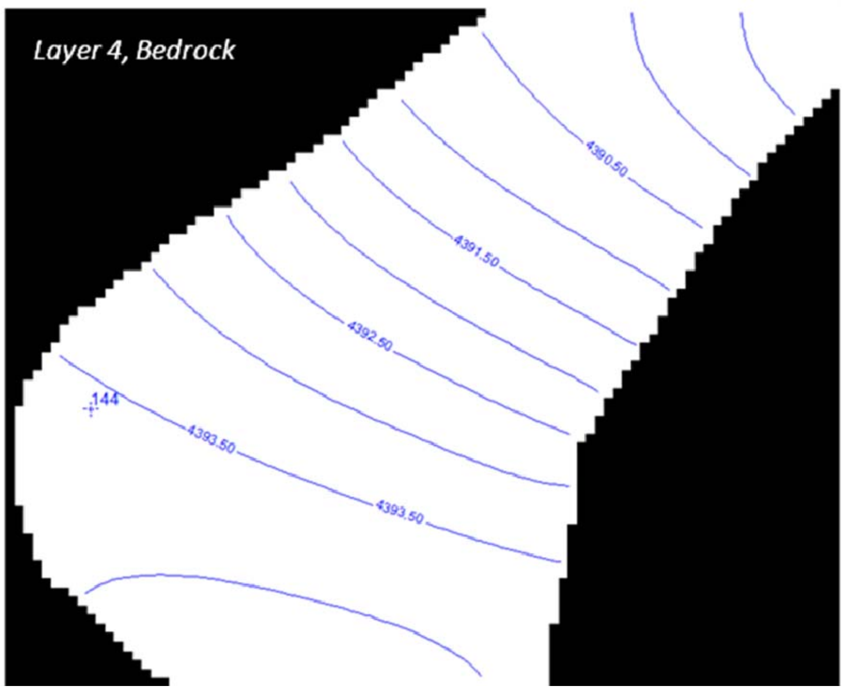

Figure A19: Modeled potentiometric surface for the bedrock zone (Layer 4) at steady-state conditions (8/2003). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Monitoring wells are shown and labeled.

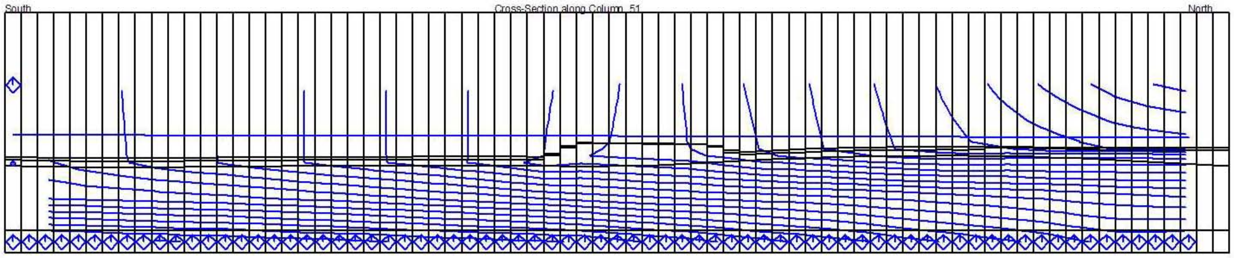

Figure A20: Steady-state head contours are shown in cross-section from south to north near well 415.

3.3.4.2 Simulation of Pumping Conditions

For the pumping simulations, the steady-state non-pumping flow simulation was modified by adjusting the boundary conditions and adding pumping well 415. Constant head boundaries for Layers 1 and 3 were modified to better simulate the potentiometric surface mapped based on the 2008 Q2 water levels, but the geometry remained the same. The zoning used in the non-pumping simulation was retained in the pumping simulation. Initial heads were imported from the results of the non-pumping simulation..

The pumping rate for well 415 was determined from the maximum sustainable pumping rate observed during a pump test in 2008 (NewFields 208b). Since well 415 is a multi-level extraction well, flow rates were distributed across screened intervals based on tracer pulse survey tests conducted as part of the Phase 2 Data Gap Investigation (NewFields 2008b). The pumping simulation used the same aquifer properties developed in the non-pumping simulation. Observed drawdown values from the 2008 pumping tests were used to confirm that aquifer properties and boundary conditions used are adequate. Simulated pumping rates were are shown in Table A11. Figures A21 and A22 show the modeled potentiometric surface for current pumping conditions (2008). Figure A23 shows the head contours in cross-section from south to north near well 415.

Table A11: Pumping rate for each of three screened intervals of well 415.

Pumping Well	X	Y	Elevation of Top of Screen (ft amsl)	Elevation of Bottom of Screen (ft amsl)	Q (gpm)
415A	558,588.1	452,227.1	4383.6	4353.7	18
415B	560,736.37	451,998.69	4353.7	4338.7	3
415C	560,878.14	452,144.64	4322.7	4310.7	26

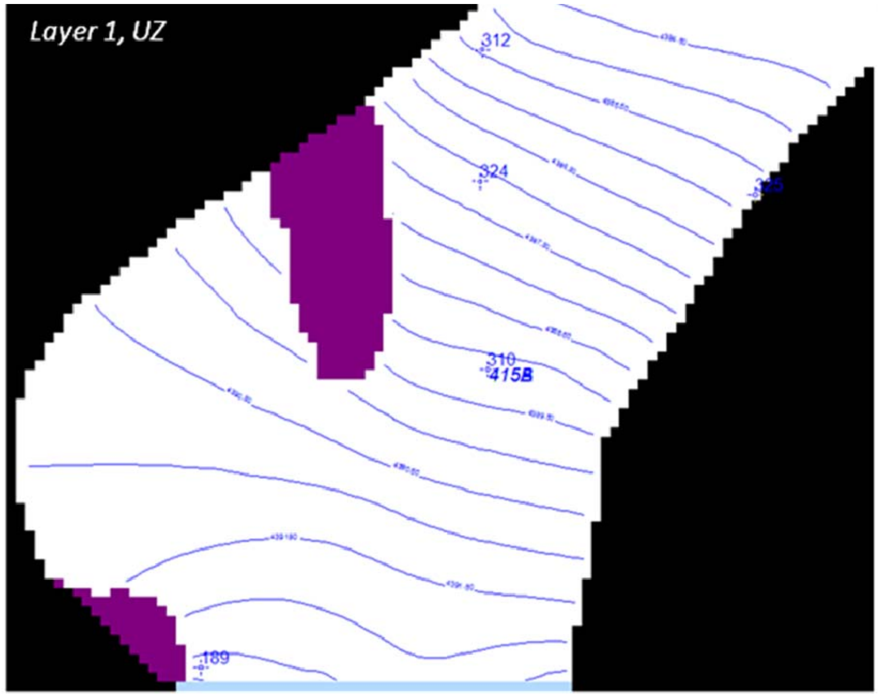

Figure A21: Modeled potentiometric surface for the upper zone (Layer 1) at current pumping conditions (2008). Light blue areas represent constant head boundaries. Black areas are zones of no flow. Pumping well are shown and labeled. Monitoring wells are shown as crosses.

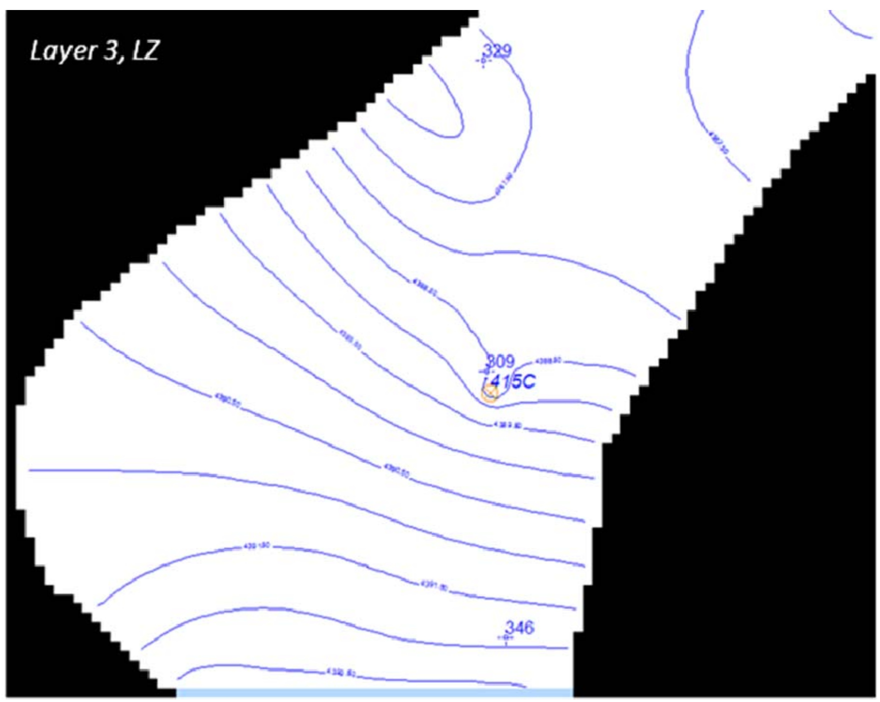

Figure A22: Modeled potentiometric surface for the lower zone (Layer 3) at current pumping conditions (2008). Light blue areas represent constant head boundaries. Black areas are zones of n o fl ow. Pumpin g well ar e s hown an d labeled. Monitoring wells are shown as crosses.

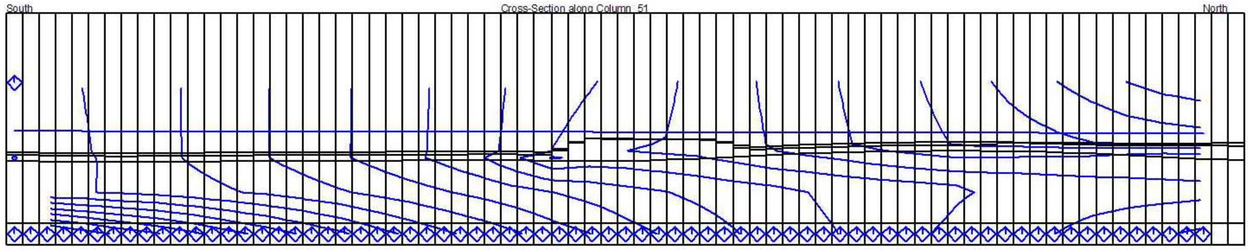

Figure A23: Head contours from the 2008 pumping condition are shown in cross-section from south to north near well 415.

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